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CONTENTS.

ILLUSTRATED ARTICLES:	PAGE.
The Influence of Wires Carrying Heavy Currents on Wires Carrying Weak Currents.—I	114
The Daft Electric Railway, Meriden, Conn	115
Electric Power Transmission in Switzerland	115
Some Possible Forms of Phonographs	116
Meeting of the National Electric Light Association	118
Telegraphy with Superposed Pulsatory and Undulatory Current Signals.—II	133
The Stillwell Live Steam Feed-Water Purifier	135
CORRESPONDENCE:	
On the Proper Size of Telephone Conductors	114

EDITORIAL:	PAGE
Paragraphs	113
The Electric Light Convention	117
MISCELLANEOUS:	
Another Curious Telephone Trouble	114
Peculiar Behavior of Incandescent Lamps	114
A Reply to Mr. Harold P. Brown	134
SPECIAL CORRESPONDENCE:	
New England Notes	138
Western Notes	136

Behavior of an Incandescent Lamp. IN another column a correspondent draws attention to the peculiar behavior noticed in an incandescent lamp placed in a position such that it was subject to the influence of a static charge. The theory which the writer puts forward in explanation of a short life lamp seems to be plausible in part, but with the destruction of the lamp in so short a time it would seem probable that under the influence of the static charge a blackening of the globe would take place, which, however, is not mentioned by our correspondent as being the case. Without knowing fuller particulars it would be difficult to form a correct estimate of the probable cause, and we should be glad to hear from other readers who have had similar experiences. We know, as a matter of fact, and as our columns bear witness to, that incandescent lamps are frequently placed in a situation where they are subject to static charges, but this is the first instance which has come to our notice in which the lamp so placed is shown to have its life shortened thereby.

A Parisian Electric Railway. So long as the London underground railway, with its use of steam and its stifling fumes, was all that could be expected in subterranean passenger traffic, it was hopeless to attempt to get other cities to adopt the system. Here in New York we resorted to the overhead lines, which are little better, for while the patrons of the road travel in open air, the people who live along the track, in the various avenues, have to submit to dust, smell and noise that are well nigh unendurable. Now, however, that electricity has demonstrated what it can do, the engineering mind reverts to underground projects, not only for New York, but for Philadelphia and Chicago. In due time some of these promising schemes will be carried out. Our English correspondent made note in his interesting letters recently of the plan now being urged in Paris for an electrical underground road there. The details are said to have been skillfully worked out, but, as usual, the municipal authorities are the stumbling block.

Phonograph Records. A SHORT while ago we published an able article by Professor Houston, in which he suggested a number of possible methods for obtaining phonographic records and reproducing them. That the subject has already been considered by not a few is shown in the article printed elsewhere, in which the author, Mr. Oberlin Smith, publishes the conceptions arrived at by him some time since. Some of these have already been suggested by others, and some are of such a nature that, as pointed out by the writer himself, it seems problematical whether they can be reduced to actual practice. Especially is this the case in that method in which it is proposed to use magnetic particles, or a magnetic ribbon, as receivers of magnetic intensity varied by the varying strength of electric currents induced by the voice of the speaker. The electrical method suggested seems probably the most promising of those mentioned by the writer. But it may be asked whether its employment will effect a gain, either in the distinctness or in the loudness of articulation of phonographs already in use, for unless such be the case the advantage is not apparent.

Science in America. IT was long since acknowledged that the conditions under which science had to gain its proper place in the estimation of the people of America were somewhat onerous, and that our philosophers, poorly equipped, and with inharmonious environment, could not be expected to make such a brilliant showing of fruits of research and investigation as the scientists of Europe, with their magnificent endowments and the stimulating atmosphere of culture which has for centuries surrounded them. Nevertheless things are on the mend, and the scientific growth of our country, under all the untoward circumstances, has become such as to inspire hopefulness and confidence as to the near future. It is in such meetings as that of the American Association for the Advancement of Science that this culture finds its best popular expression, and it is with pleasure that we note the success of the last meeting of the association just held at Cleveland. It is still too soon to expect that our association can rival the British Association, whose annual gathering is nothing short of a national event; but we have made a start, and in time the general appreciation of the value of science, as well for its practical bearings as for its high aspiration, will be as keen here as in England. Our report of the meeting last week, as full as the crowded state of our colums allowed us to make it, showed that the association is doing excellent work, and is worthy the support of all who take the slightest interest in scientific matters.

Composite Stations. AWAY back in the beginning of the electric light industry, it was regarded as a correct thing for a station to pay attention to only one class of lighting. It was either an arc light station or an incandescent station, and the lines were often as sharply drawn as they are between Unitarians and hard-shell Baptists. But it was impossible that such conditions could long exist, and to-day, as the result of various transitions, we find electric light stations as purveyors of current, doing a business of miscellaneous character. A noteworthy example of development under the new conditions will be found in our fully illlustrated article last week on the station of the Colorado Electric Company at Denver. In this instance, we have a company which is doing a good old-fashioned arc-lighting business, but which also has a large business in incandescent lighting with the alternating current system, and in addition has large city contracts for street lighting with the "municipal" series incandescent system. When to all this we add a good electric power business, it will be seen that the company has several irons in the fire, and is in shape to take advantage of all the opportunities that may offer themselves. We would specially commend to notice as worthy of imitation, the conveniences provided by the company in the laboratory for their electrician. But too often, we are sorry to say, even in large stations, the apparatus for experiment and testing is of the scantiest and crudest nature. We have heard of cases which we hardly dare mention, so absurd is it to carry on a large business without the proper appliances for regulation and measurement. This is one of the directions in which improvement is to be looked for, and we trust that the laboratory of the Denver Company will, before long, find several rivals in all parts of the country. There are many cases in which, if the electrician of a local company were supplied with instruments to the value of say $500, he could save his company ten times that amount in money in a single year.

The Danger of the Alternating Current. IN his reply to Mr. Harold P. Brown, Mr. Ludwig Gutman, brings forward a number of facts which are of special interest, considering the controversy on this subject now going on, and among which are several points of quite novel character. Mr. Gutman takes firm stand regarding the position in which the converters ought to be placed, objecting most strongly to their being relegated to the poles in the streets. This, according to his idea, is the very worst place in which they can be situated, and he strongly advocates their being fixed in protected places within buildings, where they will not be subject to deteriorating influences, which may in the end work more harm than can be done by a converter when securely housed. As he intimates, the placing of a converter in an exposed position requires it to be practically hermetically sealed, allowing of no ventilation. Notwithstanding the precautions which are taken to exclude moisture, it seems almost too much to expect that its entrance can be entirely prevented. Again, on another point, Mr. Gutman takes very strong ground in asserting that the safest system is one in which the difference of pressure between the primary and the secondary is the greatest. Where that is the case, he assumes that a safety device, such as the fuse, will be instantly acted upon, while, in the case of another system with a less difference, that action would be very sluggish in its operation. This, of course, is based on the assumption that the fusible plugs, or other safety devices are sluggish as a rule, so that they are not designed to act at a perfectly definite point. Of course, it may be argued that such is not the case, and that a safety device can be made that will act promptly. Mr. Gutman also analyzes in an interesting manner the causes which might lead to fatal effects with the use of the alternating current, and he says that the electric wires ought to remain overhead in their present position, since they are of sufficient strength to stand the strain and wear, and that the accidents which have occurred of late are to be attributed to the proximity of the weak telegraph and telephone wires, and that it is these, therefore, that ought to be buried, and not the electric light wires.

The Telephone Convention. THE meeting of the Telephone Exchange Association will begin a few days after our present issue has gone to press. The issue, though bearing date of September 8, is published more than a week in advance in order to give our readers as promptly as possible the report of the proceedings of the National Electric Light Association. We take the opportunity of extending to our telephonic friends a cordial welcome to the city, coupled with the hope that their meeting may be thoroughly enjoyable and profitable in every respect. The coming together of the two conventions in the same city, and within a few days of each other, brings out in a very striking manner the great difference that exists between the two later practical developments of electricity. In the telephonic field a great many of the troubles and difficulties have been met and conquered; in the electric lighting field it often seems that in spite of the many advances made, the future is more crowded with problems than the past has been. In telephony there is practically an entire absence of competition; in electric lighting competition is the order of the day. The low tension arc light competes with the high tension arc. The incandescent competes with the arc light. The alternating current competes with the continuous current, and the storage battery is in many respects the rival of the converter. Then besides the elements of competition, there are the many debatable points connected with overhead and underground wires, high speed and low speed engines, the merits of different kinds of belting, the advantages and disadvantages of certain practices in steam engineering, etc.—debatable to such an extent indeed, that while the telephonist wraps himself in a sweet content, the electric light man is but too often at his wits' end with worries and perplexities. Those engaged in telephony are, in fact, to be congratulated upon the stable condition of affairs with which they have to deal, although perhaps this very absence of the element of hopeful uncertainty and new opportunity may deprive the business of some of the charm and fascination that is experienced in regard to electric lighting by all who are connected with it. Evidence is given of the attractiveness of the later developments of electric light and power for telephonists, in the readiness with which a great many of them have recently become associated with lighting and power enterprises. Hence there has been a drawing together and a closer affiliation between the two bodies of men, and we trust that as time goes on it will be found that they have more and more in common, and that their oneness of interest is tending to promote friendly acquaintance and mutual esteem.

The Influence of Wires Carrying Heavy Currents on Wires Carrying Weak Currents.—I.

The committee of the Elektrotechnische-Verein, of Berlin, which had been appointed to inquire into the influence of electric light and power wires on wires designed to carry weak currents, such as telephone and telegraph wires, has just concluded its labors and handed in its report. The committee consisted of some of the best known electricians in Germany, among them Bensen, Brix, Elsasser, Froelich, Golz, v. Helmholtz, Werner v. Siemens, Wilhelm v. Siemens and others. The results obtained by the committee are as follows:

Test No. 1.—A test wire was included in an electric light cable about 500 metres in length, through which a continuous electric light current was passed. Both ends of the test wire were extended to two points at a distance, and then connected to a telephone station and grounded.

Result.—Upon repeated tests, there could be heard, in addition to the usual noises heard in telephone lines, a strong buzzing of a regular tone, which acted disagreeably upon the ear and interfered considerably with the talking.

Test 2.—One of the wires of a 3-conductor signaling cable lay parallel with an electric light cable in a trench for a distance of 500 metres, both being perfectly free. A continuous current was passed through the electric light cable, and the ends of the wire in the signaling cable were connected with telephone stations as in Test No. 1.

Result.—In addition to the usual noises heard in telephone circuits, there could be heard a buzzing and sometimes a whistling sound. Though it did not greatly interfere with the talking, it might under certain circumstances interfere with communication. The same result was obtained upon a second similar test.

Test 3.—One conductor of an underground telephone cable inclosed in an iron tube which ran parallel for a distance of 550 metres, with several electric light cables carrying currents for arc and incandescent lights and at a distance of from 1 to 1½ metres. The outgoing and incoming wires of the electric light cable lay next to each other, but the same strength of current did not pass through both leads. The ends of the telephone conductor were connected to telephone stations at a distance and then to earth.

Result.—Beside the usual ones, several trials failed to establish the presence of other noises.

Test 4.—An overhead telephone line of considerable length which crossed a railroad station at almost right angles, and which was under the influence of the alternating currents employed in lighting the station. The wire was about 20 metres vertically above the dynamo building. The telephone line was connected to telephone instruments and then to earth.

Result.—In addition to the usual sounds, there could be heard a continuous rumbling, disturbed, musical sound, by which the perfect reception was more or less interfered with.

Test 5.—One conductor in a long underground telephone cable enclosed in an iron tube, which ran parallel for a distance of 1,000 metres, at a distance of 1 to 1½ metres, from several electric light cables carrying continuous currents. The out-going and return wire of the electric light cable went side by side for some distance. One end of the conductor of the telephone cable was carried overhead to a station and there connected to the telephone and then to earth. The other end was directly connected to the instrument and to earth.

Result.—This test had the same favorable result as that given in Test 3.

Test 6.—A somewhat extended Morse telegraph circuit and a telephone cable of the usual type were contained in iron tubes, and ran for about 550 metres, at a distance of 1 to 1½ metres from each other, parallel to an arc light wire carrying continuous currents.

Result.—The telephone instruments included at both ends of the wire failed to detect any other than the usual noises.

Test 7.—An ordinary overhead telephone circuit which was situated entirely beyond the influence of an electric light station.

Result.—Only the usual noises were heard.

With regard to the pernicious influence of alternating currents on telephone lines crossing them, as described in Test 4, further tests were made to determine the influence of alternating current upon parallel telephone circuits. The length of the closed metallic circuits employed during the test was about 200 metres.

Test 8.—A so-called "concentric" electric light cable, in which the current strength reached 120 ampères, and a copper wire insulated with gutta-percha, was employed for the telephone circuits. The position of the circuits is shown in Fig 1.

Result.—No disturbance could be heard in the telephone; communication was perfect.

Test 9.—The incoming and outgoing circuits of the electric light cable were separated for a distance of 15 centimetres; the gutta percha covered wire, serving as a telephone circuit, was placed between the electric light cables; the current in the electric light cable amounted to 58 ampères. See Fig. 2.

Result.—In the telephone could be heard a soft whistling sound, which, however, was not essentially disturbing.

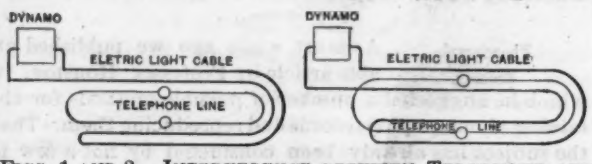
Test 10.—The arrangement of the electric light cables was similar to that of Test 9. The current strength was again 58 ampères. The telephone circuit, however, was run outside the electric light cables, as shown in Fig. 3.

Result.—A strong, deep, buzzing note was heard in the telephone and communication was difficult.

Test 11.—The arrangement of the circuits was similar to that of Test 10, but the inner loop of the electric light cable was cut out. The current strength was 120 ampères, the arrangement being as shown in Fig. 4.

Result.—The buzzing was still more marked in the telephone than in Test 10; communication was very difficult

The result of these tests warranted the committee in formulating the following conclusions: Electric light circuits carrying continuous current exercise no disturbing influence on neighboring overhead or underground telephone circuits if the outgoing and returning leads of the electric light wire lie essentially next to each other, and the current is approximately equal in both leads.



FIGS. 1 AND 2.—INTERFERENCE BETWEEN TELEPHONE AND ELECTRIC LIGHT WIRES.

It would appear desirable, also, to separate the two kinds of circuits as far as possible, and to inclose the telephone circuits in heavy iron armor. Alternating current electric light circuits show themselves to be so disturbing in the operation of telephone circuits, that the distinctness of communication is jeopardized, even when the telephone circuits cross the electric light circuits. When the two circuits run side by side communication is no longer possible.

No disturbance of telephonic communication, however, is noticeable with alternating currents when the outgoing and returning leads are contained in the same cable, as is the case with the so-called "concentric" electric light cable.

Another Curious Telephone Trouble.

BY A. A. KNUDSON.

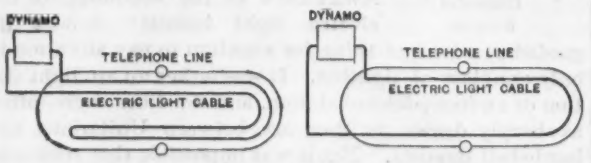
I notice in the columns of THE ELECTRICAL WORLD of Aug. 25, 1888, an article by Mr. John C. Crawford, of Reading, Pa., entitled "A Curious Telephone Trouble." It was read by me with much interest, as it brought to my mind a somewhat similar experience of my own in Nova Scotia, which I will here give.

A telephone line was built during the present summer, running from Bridgewater, Nova Scotia, to the gold mining district, some 30 miles distant. One end was connected with the telephone exchange at Bridgewater through a magneto bell, and thence to ground. The other end of the line terminates at the office at the mine in the same way. There are some three other offices on the line, intermediate, at about equal distances apart.

When the line was finished a *steady flow of electricity* was found to be passing over it, much to the detriment of signaling. At first a cross was looked for, but no other wires were near it except in the town, and they were some distance away.

The wires connecting with the main or calling battery were then examined (the exchange being on the Law system), it being supposed that they were crossed in some way with this line, but after disconnecting the wires entirely from the battery the current was still there.

Tests were then made to locate the fault by disconnecting one side and grounding the other at the intermediate stations on the line, when the source of current was found to be from *the gold mine end.* Our engineer not having had any previous experience in dealing with a case of this kind reported the facts to me at Halifax, and after getting all the details in connection therewith I came to the following conclusion as to the true solution of the matter:



FIGS. 3 AND 4.

In the immediate vicinity of the gold mine are other mineral deposits, more or less rich, of copper, silver, lead and iron. These metals, it is well known, form the positive and negative elements of a galvanic battery when properly placed in jars with an exciting fluid. In this particular case the copper, silver or lead ores, either separately or combined, would probably act as the negative and the iron as the positive, the earth and rocks would represent the porous cell and the water and moisture complete the construction of a huge galvanic battery, the size of which can only be conjectured. When our engineer drove his ground bar down with the intention of establishing an ordinary earth connection, he most unexpectedly placed on tap the current from an underground battery. This theory of an earth battery would seem to be strengthened by the fact that on rainy days the current is *stronger* than at other times, which is easily accounted for.

The amount of current on the line is not sufficient to cause a total interruption of the signals, but requires an extra amount of "elbow grease" in turning the crank, and often repetitions to get the bells to ring. There is no trouble in talking.

In following out this theory it is quite consistent to believe that the capability of this underground battery is quite large, and that from its very nature and location it is always on a "short circuit," and that only a very small portion shows itself on the line.

The remedy I propose for this state of things would suggest itself to others in the business, namely, to run an extra wire back on the same poles from the mines, and try a new ground, say at every half mile, with the hope of getting *outside* of the battery. If that did not remedy it, a metallic circuit would have to be built.

Peculiar Behavior of Incandescent Lamps.

BY ARTHUR J. NEWELL, HOLYOKE, MASS.

There has been brought to the writer's notice the peculiar action of an incandescent lamp in one of the paper mills in this city, and, believing that there has been nothing of the kind in print before, he sends the facts to THE ELECTRICAL WORLD, thinking that it may be of interest to some of its readers, and that it may possibly bring out something of interest to all.

The lamp is suspended in front of a calender at the end of a machine, and the trouble is that the lamp will not burn its guaranteed life, but gives out after a run of from thirty-six to forty-eight hours. It was at first thought that a bad joint might vary the resistance in the circuit, and thus shorten the life of the lamp; but, upon examination, the joints were found to be well soldered, and no chance for trouble showed there.

The socket has been changed, with no effect, which proves that a poor fit in the socket could not be the difficulty. In fact the lamp shows no change of candle-power while burning, which indicates that the short life cannot be the result of a varying resistance in the circuit. The lamp does not burn above its normal candle-power while it lasts, and it cannot receive too high a potential, as it is the last on the line, there being seven or eight nearer the machine which burn all right.

The theory which the writer has as to the cause is based upon this fact: At the point where the light hangs, the atmosphere is charged with static electricity, which is generated while the paper is being calendered. The explanation then is that the static charge disintegrates the filament and thus shortens the life of the lamp. In support of this theory may be cited two facts: That when the light is hung away from the charged atmosphere it burns its full life, and that this is also the case when a paper is being made that requires steam in finishing, which prevents the atmosphere from becoming highly charged. The question is, how does the static electricity affect the filament?

On the Proper Size of Telephone Conductors.

To the Editor of The Electrical World:

SIR: In the issue of THE ELECTRICAL WORLD of Aug. 11 I undertook to demonstrate, mathematically and experimentally, that a copper conductor of No. 21 gauge would work better on a circuit of one mile in length in cities where telephones are subject to inductive disturbances than a No. 16 gauge having twice the surface. Instead of reading "theoretically increased the magnetic effect six per cent.," it should have read "theoretically decreased."

Mr. Lockwood undertakes to argue that if a No. 16 conductor works well two hundred (200) miles, it is the proper and economical gauge for a circuit of one mile in length, and that we should increase the current, so far as the conductor is concerned, two hundred-fold. He says every telephone manager knows that, although not in those words. If so, why does he rush into print to tell them what they already know?

I have known telephone companies to use No. 16 gauge copper for circuits of one quarter mile or less, when it may be demonstrated that a smaller conductor answers to a better purpose. If Mr. Lockwood in his position has been instrumental in inducing the telephone companies to expend needless sums of money for copper on the average lengths of their short circuits he is welcome to the credit due him, as he claims he has been preaching that doctrine since 1880. DAVID BROOKS.

PHILADELPHIA, Pa.

A New Telegraph Service.—Mr. Rowley, of Cleveland, O., arrived at Onset last week and has been presenting a new wrinkle in the "spirit" business. He calls himself a telegraph medium. He places a telegraph sounder in a box, and if the "conditions" are right a "spirit" wires a message from "over yonder." Out in Capt. Nate Besse's boat last Thursday a message was received from H. W. Beecher, in which he was credited with the expression: "I was quite liberal when on earth, but not half as liberal as I wish I had been." Dr. Holland wired from the unseen land: "Don't believe everything you hear or see, without investigation."—*Onset Bay Times.*

The Daft Electric Railway, Meriden, Conn.

On the 16th of last July the Meriden Horse Railway Company inaugurated electrical propulsion upon its lines. Near the end of last year its stables were destroyed by fire and its stud nearly annihilated, and, in considering the question of rehabilitation, it decided to resort to electricity for motive power. After a most thorough and painstaking examination of various systems, the company's choice fell upon the Daft, and in March its arrangements were concluded with the Daft Electric Light Company and the work begun.

The line aggregates 5¼ miles and diverges in three branches; one passing through Main, Curtis and Broad streets; another through Pratt and Hanover, and another through Colony, Britannia and Griswold, including some stiff gradients and frequent curves.

The method of conduction is by overhead wires, which serve for both the outgoing and incoming currents, thus avoiding the interference with telephones which is inevitable where the rails constitute part of the circuit. The system embraces some features of great practical value, such as using trolley wires sufficiently small and flexible to allow uniform tension, perfect alignment, and freedom from "kink," without too greatly reducing the potential—by conductive resistance—at the end of the line; also the ability to undergo a rupture of trolley wires without interrupting the service, except in the span at which it occurs.

Shapely posts painted a neutral color stand in opposite curbs, and the positive conductor passes over those on one side the street and the negative over those of the other side. Opposite poles are connected by hard-drawn copper wire spans sustaining the trolley-wire hangers over the track, and, by an ingenious arrangement of connections and insulators, lead the current from the mains to their respective trolley wires. The posts are surprisingly unobtrusive and so accurately aligned that, in ranging one's self with them on any of the tangents, the nearest completely hides all the rest from sight.

The power station is on the site of the company's burned stables in Pratt street, and is equipped with three Armington & Sims engines of 50 h. p. each, and ample boiler power, the electrical plant being three Daft dynamo-generators, also of 50 h. p. each. In conformity with a canon of the Daft system, the current potential is far within the danger limit, being only 220 volts.

The rolling stock consists of twelve 16-foot closed cars equipped with Daft railway motors of 15 h. p. each, that are well up to their work, of which an idea may be obtained from the illustration representing one of the motor cars on an 8.4 per cent. gradient in Main street. It makes a uniform speed of six miles per hour up and down the ascent, and finds the climb much less of an obstacle to electric propulsion than it has proved to animal traction.

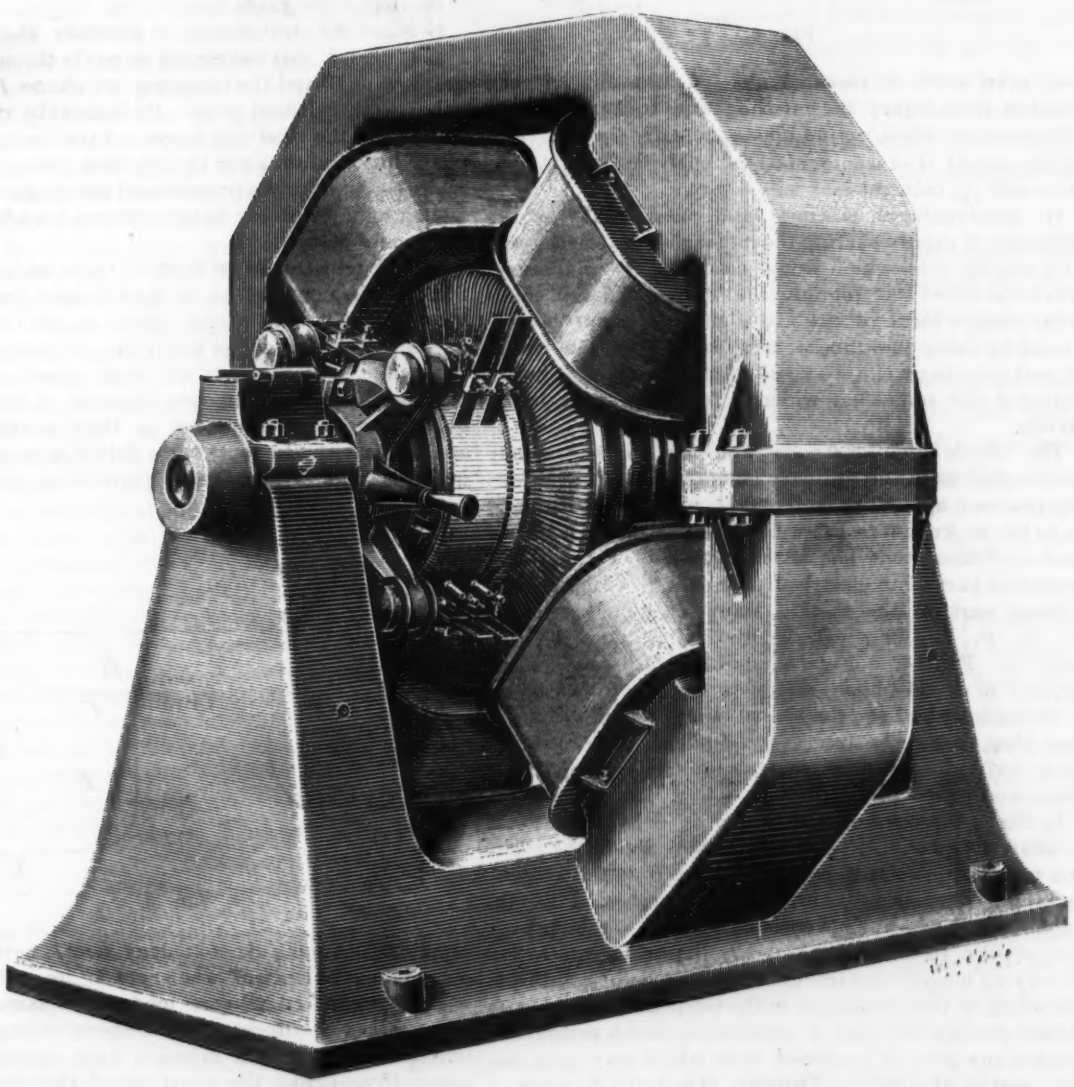
DAFT ELECTRIC ROAD AT MERIDEN, CONN.

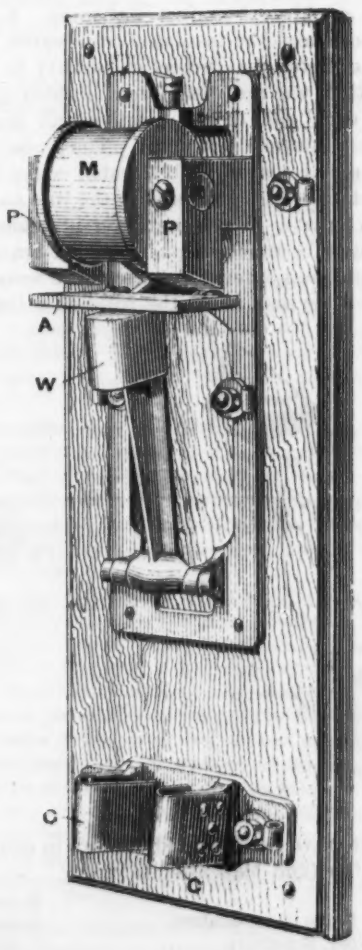
At present writing only three and four-fifth miles of the track is ready for use, and but five motor-cars are running. Both these incompletions will, however, be made up well within the contract term, and another month will see the road in full operation. It will then be one of the largest and finest of its kind in England, but will undoubtedly soon be supplemented by several more.

Electric Power Transmission in Switzerland.

We have already noted in these columns a number of installations for the transmission of power designed by Mr. C. E. L. Brown, of the Oerlikon Machine Works, at Zurich, Switzerland, and this week we give a description of a late installation in which Mr. Brown employs a new four-pole machine of his design.

The plant we are about to describe has been erected in Piovene, near Schio, in Upper Italy, to the order of Signor Gaetano Rossi, and serves to carry the power given off by a 250 h. p. American "Victor" turbine in the valley to a mill situated on a neighboring hill. It was partly on account of the great difference in level between the turbine house and the mill that electric transmission has been adopted, teledynamic transmission becoming very difficult when the position of the ropes deviates much from the horizontal. The total distance between generator and motor is 450 metres (nearly 500 yards), and the guaranteed commercial efficiency of the plant is 78 per cent. Our illustration, Fig. 1, for which we are indebted to our excellent contemporary, *Industries*, shows a perspective view of the generator, which is driven from the turbine shaft by a link belt 20 inches wide, and is designed to give a current of 270 ampères at 625 volts pressure when running at 500 revolutions per minute. The motor is of similar design, but its armature contains about 8 per cent. less iron and windings. The field magnets are entirely of cast-iron, and of the four-pole type; there are four exciting coils each containing 58 convolutions of square wire, and all the coils are coupled in series. The armature of the generator is 960 mm. in diameter by 500 mm. long, and is Gramme wound with 400 turns of 6 mm. square wire having a sectional area of 36 sq. mm. The core of the armature consists of wrought-iron discs, which are mounted upon a gun-metal flanged cylinder made in two parts. The joint between the two parts is a broken line, so that even those discs which are

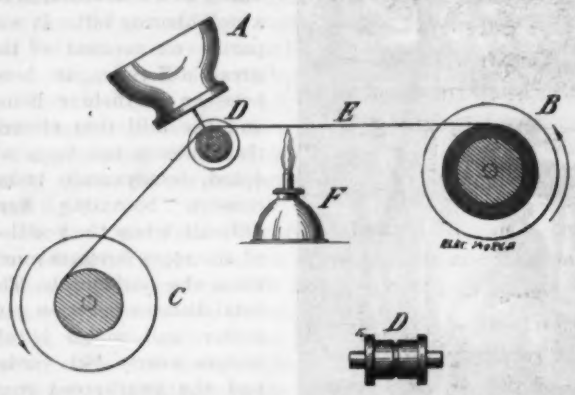




FIGS. 1 AND 2.—ELECTRIC TRANSMISSION OF POWER IN SWIZERLAND

over or close to the joint are well supported, and after the insertion of the discs the two parts of the supporting cylinder are drawn together by the bolts shown, and the outside of the flanges is insulated by wooden rings. There are four sets of brushes, two positive and two negative, diametrically opposite brushes being coupled together.

The electro-magnetic inertia in a circuit conveying 250 h. p. is necessarily very large, and on this account it would be dangerous to break the whole current suddenly. It would therefore be inadmissible to insert a fuse or other form of cut-out into the circuit, as might be done with smaller machinery, in order to save the generator from the effects of an accidental short circuit or heavy leak on the line. Any type of cut-out interrupts the current



FIGS. 1 AND 2.—SOME POSSIBLE FORMS OF PHONOGRAPH.

suddenly, and must therefore not be used where the self-induction of the circuit is at all considerable. To overcome this difficulty, and yet protect his generator effectively, Mr. Brown in all his transmission plants employs an automatic arrangement by which the field of the generator is demagnetized as soon as the line current exceeds a certain value. This apparatus, which is shown in Fig. 2, is an automatic circuit closer, the contacts *C C* of which are coupled to the terminals of the exciting circuit of the field magnets of the generator. The main current, before it is sent into the line, is caused to flow through the exciting coil of an electro-magnet *M* with poles *P P*, below which is pivoted an armature *A*. With the normal strength of current, the excitation of the magnet *M* is insufficient to cause attraction of the armature: but if a certain strength of current be exceeded, the armature is lifted, and liberates a catch by which the weight *W* is ordinarily held up. The weight then swings round on its arm, and with the force of a hammer jams itself between the spring contacts *C C*, thus short circuiting the field coils on the generator, which has the effect of at once lowering the E. M. F. to the very small amount due to residual magnetism. In a transmission plant, where an overhead line is used, care must be taken to protect the machinery against lightning. Both generator and motor should be insulated from earth, and, in addition, some lightning protectors should be fitted. In the installation we are describing, lightning protectors are fitted at each end of the positive and negative line, but not at any intermediate point. The protector consists of a pair of metal plates with serrated edges facing each other, one plate being connected to the line and the other with an earth plate. That the electric transmission of energy has now become a most important branch of work in Switzerland and other countries where water power is abundant, will be seen from the following list of instal-

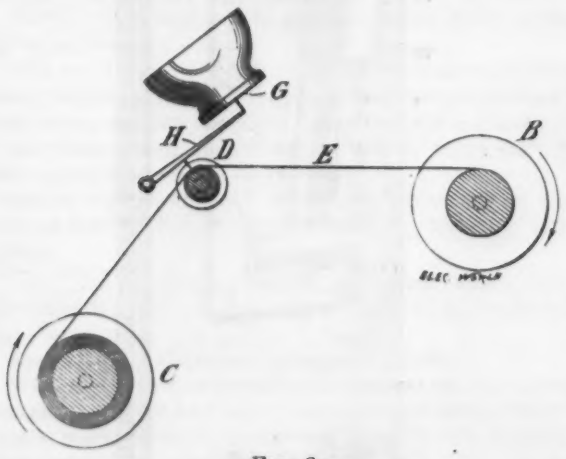


FIG. 3.

lations which have been erected, or are in course of erection, by the Oerlikon Maschinenfabrik:

Name of installation.	Horse-power.	Distance. Metres.
J. Müller-Haiber, Solothurn	50	8,000
Gaetano Rossi, Piovene, Italy	250	450
The Worsted Yarn Mill of Derendingen, Switzerland	280	1,300
J. Amman & Wepfer, Pordeone, Italy	60	1,000
Troller Bros. & Co., Lucerne	120	3,000
R. & M. Frei, Aarau	15	1,000
J. & M. Legler, Diesbach, Switzerland	120	600
Paper Mills, Steyrermühl-Aichberg, Austria	100	600
C. F. Bally, Schoenenword, Switzerland (combined with electric lighting)	12	500
Bay & Co., Steinbach-Berne	15	1,300
J. Rauch, Mühlau, near Innsbruck	50	600

Some Possible Forms of Phonograph.

BY OBERLIN SMITH.

There being nowadays throughout the scientific world great activity of thought regarding listening and talking machines, the readers of THE ELECTRICAL WORLD may be interested in a description of two or three possible methods of making a phonograph which the writer contrived some years ago, but which were laid aside and never brought to completion on account of a press of other work.

One of these methods is rudely shown in Figs. 1, 2 and 3, the construction and operation being as follows: *A* is a mouth piece and diaphragm, with spring and indenting needle, as in the Edison machine. *B* is a reel, carrying a thin ribbon *E* of iron, steel or other substance capable of being temporarily softened by heat. This ribbon is unwound from *B* and wound on to another reel *C*, which is revolved slowly by clock work or other means. *D* is a supporting roller (or stationary bar) with a flat groove the width of the ribbon *E*, and having a V-groove in the bottom of it for the needle to descend into, as seen in Fig. 2. *F* is a heating lamp, which, of course, must be protected from draughts, etc. All this is the recording apparatus or transmitter. The ribbon *E* being short at the point where, for the time being, it is hot, receives the indentations as easily as the tin-foil, or more so. It cools by the time it gets to reel *C*, and is then much harder and more durable than tin foil. The same apparatus can be used for the "talker," as in Edison's machine, but advantage may be taken of having the indented ribbon made of a hard substance by using a special talking diaphragm *G*, Fig. 3, which will augment the vibrations in amplitude by means of a lever *H*, the ribbon *E* being hard enough not to lose its form by the increased pressure due to the leverage, as tin-foil would do.

The probable advantages of this form of apparatus are: 1. The loudness of voice produced by the increased amplitude of vibration. 2. The simplicity and cheapness of the whole machine—requiring no accuracy in "registering" devices beyond having the groove in roller *D* to about fit the width of ribbon *E*. 3. The cheap material of which the ribbon may be made. 4. Durability of rib-

FIG. 6.

bon, even with oft-repeated use. 5. Convenience and freedom from injury in handling and transporting the ribbon-record when wound upon spools like thread. This ribbon would, if of iron or steel, probably be about $\frac{1}{10}$ inch wide and $\frac{1}{100}$ inch thick.

Its disadvantages, possibly fatal ones, would be the difficulty of evenly heating the metal ribbon and the probable rasping noise which would occur in the diaphragm when the sound was reproduced. A modified and somewhat simpler form of the above process might be employed by using an ordinary wire instead of the ribbon *E*, and allowing a chisel-shaped needle to indent it into a flattened and somewhat widened form, wherever it was struck.

The above two methods are, of course, wholly mechanical, as in the ordinary phonograph. The following proposed apparatus is, however, *purely electrical*, and is, as far as known to the writer, the only one fulfilling such conditions that has been suggested. Fig. 4 is the recording part of an electrical phonograph. Fig. 5 is the talking part of the same. Many of the pieces, as *D*, *E*, *B*, *C*, etc., can be the same ones as are used in Fig. 4. Fig. 6 shows the same ideas applied to a telephone line wire, so as to speak at a distance and at the same time record what is said, thus making a *recording telephone*. The sketches show only the essential parts, without the supporting framework, etc.

In Fig. 4 the voice or other sound is delivered into an ordinary telephone *A*. Preferably, this should be a carbon transmitter so as to have a battery *F* in the circuit, and thus use as strong a current as practicable. Possibly, however, a Bell telephone without a battery would answer the purpose. In either case the current, broken into waves of varying lengths and intensities corresponding with the vibrations of the diaphragm in the telephone, passes in its circuit through the helix *B*, converting into a permanent magnet any piece of hardened steel which may be at the time within the helix. Through this helix *B* passes a cord, string, thread, ribbon, chain or wire *C*, made wholly or partly of hardened steel, and kept in motion by being wound on to the reel *E* from off the reel *D*, *E* being revolved by hand, clock-work or other means. *J* is a tension spring or brake pressing against *D* to keep the cord *C* taut.

When in operation with the undulatory current from the telephone *A* passing through the helix, the cord *C* becomes, so to speak, a series of short magnets grouped into alternate swellings and attenuations of magnetism. The actual lengths of these groups depends upon the speed of their motion, but their *relative lengths* depend upon the *relative lengths* of the sound wave; and their *relative intensities* depend upon the *relative amplitudes* of these waves. The cord *C* therefore contains a perfect record of the sound, far more delicate than the indentations in the tin-foil of the mechanical phonograph. The probable construction of *C* would be a cotton, silk or other thread, among whose fibres would be spun (or otherwise mixed) *hard steel* dust, or short clippings of very fine steel wire, hardened. Each piece would, of course, become a complete magnet. Other forms of *C* might be a brass, lead or other wire or ribbon through which the steel dust was mixed in melting—being hardened afterwards in the case of brass or any metal with a high

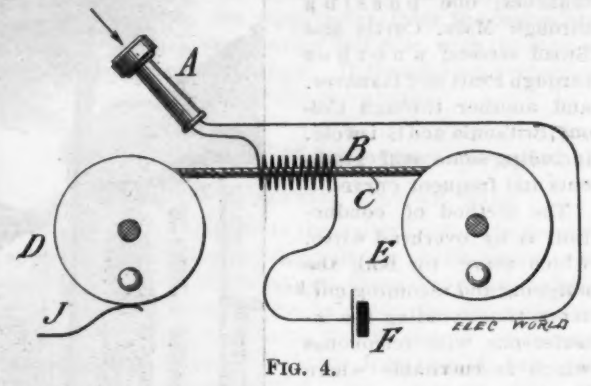


FIG. 4.

melting point. Another (but too expensive) form of *C* would be a chain with each link a magnet; or, if the magnets affected each other too much when in contact, each alternate link could be of non-magnetic material. This chain would not be as delicate as the dust magnets, because the effects of a given vibration might extend but part way along a link. Another imaginable form of *C* would be simply a hard steel wire, but it is scarcely possible that it would divide itself up properly into a number of short magnets. The magnetic influence would probably be distributed along the wire in a most totally depraved way, with nodal points just where they were not wanted. If it could be made to work it would obviously be the simplest thing yet suggested.

The cotton thread above mentioned would seem to be preferable to anything else on account of its cheapness, lightness and flexibility. The Lord's Prayer could be written upon a few feet of thread or string, while a young lady receiving a small spool of cotton from her lover would think herself abominably neglected if it was not "warranted 200 yards long."

In Fig. 6 the arrangement is precisely the same as in Fig. 4, except that the circuit is made through the telegraph wire *W* and the receiving telephone *H* in Boston or some other distant place. Of course the record might be made at the receiving instead of the transmitting end of the line, and thus our hypothetical young lady might, while listening to the impassioned pleadings of her chosen young man, be preparing the evidence for a future breach-of-promise suit.

To make the thread or cord *C* "talk back" it is, after having been rewound on to reel *D* again drawn through a helix *B*, Fig. 5, in whose circuit is the "talking" telephone *A*, probably a Bell receiver. Of course it is drawn through at approximately the same speed as before. In passing, the small permanent magnets in the cord *C* induce currents of electricity in their enveloping helix analogous to the currents in the field of a magneto-electric machine, or a dynamo with permanent magnets in its

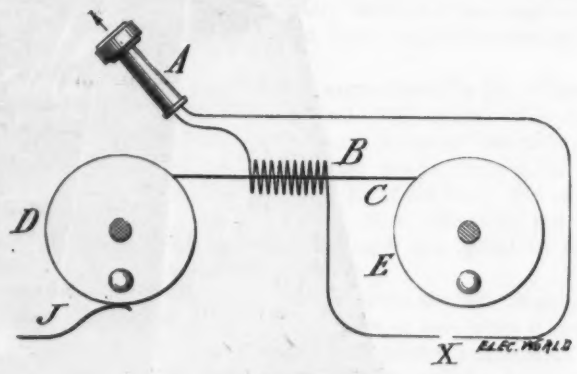


FIG. 5.

armature. A more exact analogy would, however, be the currents in the helix of a solenoid if its ordinary action were reversed, and its core made a permanent magnet. These waves of current will correspond in length and relative intensity with the original wave currents, and will therefore reproduce the vibrations of the original sound in the diaphragm of the telephone at any time in the future. If such induced currents are not strong enough to produce sufficiently loud sounds it may be possible to insert at *X*, Fig. 5, some intensifying apparatus, such as a battery, but which has not yet been thought out.

Like the two mechanical methods first mentioned, this electrical method has never been worked out to completion. The writer went far enough with it to build a temporary apparatus and to develop a successful machine for spinning metallic dust into a cotton cord, but was

obliged to lay aside the whole thing before arriving at any *acoustic* results. His experiments showed that it was difficult, with ordinary tools, to harden steel filings on account of excessive oxidation. Experiments with hardened steel wire, broken in a special machine into very short pieces, showed that they must not be too short —say not less than three or four times their diameter—or they could not be saturated with magnetism to any appreciable degree. Possibly this is because the poles (or points of maximum polarity) of a magnet lie at some distance from the ends of the bar, and consequently neutralize each other when the bar is too short. If this theory is correct it would prevent making magnets of steel dust, the grains of which are supposed to be about as broad as they are long.

To digress a little, it may be remarked that such a theory does not seem to agree with the fact of a magnetic polarity in approximately spherical or cubical bodies, like the earth, or a chunk of loadstone. Possibly, however, they would be much stronger magnets if elongated; and the tiny pieces of wire above referred to, may possess as much strength in proportion, though it be scarcely perceptible on account of their smallness.

The writer confesses to a good deal of ignorance upon the subject, but he was somewhat surprised to find an equal amount in several well known electricians whom he consulted; and also to find that none of the books he had at hand gave any definite data regarding the best proportions for permanent magnets or their actual strength (when saturated) in pulling power. Surely, there is in this department of electrical science a good sized (magnetic) field for a number of lines of force—mental ones—to work in, in the way of careful experimenting.

To return to our magnetized cord as a "phonogram," it is possible that an insuperable objection to it would be found in the great diameter and length which would be required to hold magnets of sufficient strength and quantity. This, however, can be determined by experiment only. Of course if this cord approached a clothes line rather than a piece of sewing silk, in its general proportions it would be utterly useless as a practical recording medium. Regarding the general convenience of a record in a cord or ribbon-like form compared with one indented upon a cylinder or a flat circular tablet, there are probably advantages on both sides. One disadvantage of the cord is that if some small portion of the record near the middle has to be repeated there is a good deal of unwinding to do to get at it. The same objection, if it be one, applies to the first-mentioned methods, as well as the magnetic cord. In practice, however, it might prove that this unwinding was a small matter, if a rapidly-working automatic winder were used.

Another general principle which may perhaps be adopted for a phonograph is that of *variable conductivity*. Possibly a cord or ribbon may be made of a poor conductor (perhaps a flexible substance impregnated with carbon), and may then be made better and worse in certain spots by the action of the "transmitting" instrument, either by making spots of the cord denser or thinner, in some way, at the inward stroke of the diaphragm. This recording action would probably be entirely mechanical. The reproducing, on the contrary, would be wholly electrical, and would consist of passing a current through a conductor which was broken by a space filled by the cross-section of the moving record. This current would pass through a receiving telephone and would, obviously, be thrown into the proper undulations of strength by the varying conductivity of the cord, as it passed along by the motion of its reels.

The writer has not worked out the details of this latter scheme as completely as in the others mentioned—even upon paper. He has not the time, to say nothing of a properly equipped laboratory, to carry the ideas suggested to their logical conclusion of success or failure, and, therefore, makes them public, hoping that some of the numerous experimenters now working in this field may find in them a germ of good from which something useful may grow. Should this be the case, he will doubtless get due credit for his share in the matter; but if, on the other hand, these suggestions prove worthless, they will still have served a purpose, on the principle that a demonstration of what *can't* be done is often a pertinent hint as to what *can* be.

The Edison Patents in England.—A notice has been issued by the Edison and Swan United Electric Light Companies, of London, to the effect that the late decision invalidating Mr. Edison's patent has been appealed from, and that the appeal will probably be heard before Christmas.

Reporting Electrical Executions.—Elbridge T. Gerry says that the New York newspapers will have no accounts of the first execution of a criminal by electricity in this State. Though Mr. Gerry is an authority on this subject, the managing editors of New York ridicule his statement in question, as well as his threat that any editor who, contrary to the statutes, publishes such an account, will be imprisoned for a misdemeanor. The editors agree with Chester S. Lord, of the *Sun*, that considerable imprisonment would be necessary to break up their habit of printing the news. Julius Chambers, of the *Herald*, says that a paper which had sent to the Polar Sea for news wouldn't mind the trivial danger of imprisonment. Another editor said: "There would be a struggle for the distinction of such an imprisonment."

THE ELECTRIC LIGHT CONVENTION.

The pages immediately following this will be found to contain a very full and complete report of the Convention of the National Electric Light Association just closed in this city. We believe that the promptitude with which the report is issued, and the care taken in its preparation, will be generally appreciated, the more especially when it is borne in mind that during the session we have issued no fewer than four editions of our bulletin, now so familiar to all frequenters of these meetings. As to the paper itself, we may "point with pride" to its size, not less than to its contents. It is four pages larger than any previous issue. At the August Convention last year we printed a paper of 56 pages. For the convention in February at Pittsburgh we printed 64 pages. Our number this week contains no fewer than 68 pages. We may point out too, that while the paper is so large, it is not late; but on the contrary is actually issued eight days ahead of date, and one day after the close of the Convention. This special effort has necessitated a little departure, it will be observed, from our usual method of making up the paper.

The growth of the electric light and power industry was admirably brought out by President Duncan in his brief but pithy opening address. The figures have, we are glad to see, arrested general attention, and the direct outcome of the publicity thus given to these facts will be a development of new work.

Perhaps the leading question before the Convention was that of overhead and underground wires. Mayor Hewitt was not slow in winning the applause of the meeting with his address of welcome, in which he vindicated his line of policy as to the overhead wires, and it must be said that a better address in form and matter than the Mayor's has not been made before the body. At the same time, what we may call the progressive element had its inning in the papers presented by Dr. S. S. Wheeler and Mr. Chenoweth. The paper of Dr. Wheeler will be found worthy of study, based as it is upon an intelligent comprehension of the subject as a whole and a full knowledge of the work being done in this city. Supplementing all this is the excellent paper by Mr. Acheson on disruptive discharges in cables, and the various discussions. Any one who reads that part of the report will certainly be abreast of the latest information of the day on the underground wire problem.

We have no doubt that when Mr. Leonard reads of the cordial reception given to his unpretentious but valuable little paper detailing his experience in Minneapolis with petroleum fuel he will be somewhat surprised. Like some other members, he appears to be afraid of boring the Convention, but the fact is that such papers, with their facts and details on vital questions of management, are the best that can be brought before the Association, which does not meet to discuss scientific theories, but to arrive at all the facts that concern the practical operation of light and power plants.

While we do not consider the choice of the Hotel Brunswick as the meeting place to have been at all a happy one, it is the opinion of all that the coming to New York has been a good thing, and that the Convention has been one of the best, and thoroughly enjoyable. NewYork is the capital of the country in every sense of the word, and will remain so, and it is also a convenient point of rendezvous for all who are interested in electrical matters. Moreover, it was three years since the Association visited the city, and the time was fitting to make a new impression on the metropolitan consciousness. The reputation of our city for hospitality, also, has been well maintained, and not a delegate can go home without feeling that everything possible was done to render his sojourn here pleasant and profitable.

In speaking above of the impression made by the Convention on the metropolitan consciousness, we have reference more particularly to the manner in which the press has dealt with the proceedings. Having attended all the conventions, we make bold to say that never before have the reports as a whole been so full, so fair and so accurate. In fact, it is hard to pick out the best, where all have been so good. The evening papers have greatly gratified the officers and members by the excellence of their reports. On Thursday night, for example, the *Evening Post* published two full columns, the *Commercial Advertiser* had a column and a half, excellently done; and the *Mail and Express* supplemented a column of good report with another column of elegant and philosophic editorial. The New York *Graphic* made first-class portraits of the officers, and the *World* also came out with its neat thumbnail sketches of prominent speakers, while the *Sun*, *Herald*, *Tribune* *Times* and others gave the convention an unusually large amount of editorial notice and reportorial care. If we may venture to do it, we would heartily congratulate our brethren of the daily press on their good work. They have certainly done the Association good, and we think that hereafter the electrical questions that come up will receive better treatment at their hands than has sometimes been the case hitherto.

It is natural that the electric power question should occupy part of the time of the Association, and the hour devoted to Mr. Lufkin's able paper was well spent. It will be noticed that the paper is an able effort to determine the average running of motors in the different classes of employment, so as to have data from which to deduce the right schedule of charges. This is a highly important part of the motor question, and affects very closely the prosperity of the business. It will be seen also that Mr. Lufkin dwelt upon the interesting question of small motors versus large motors. There is evidently something to be said on both sides, and it is likely that the matter will long be one provocative of differences of opinion in motor circles.

The various presentations made during the Convention were, after all, but a small recognition of services rendered the Association. The Association, as it stands to-day, is largely Mr. Morrison's handiwork, and it is only appropriate that his zeal and the wise use made by him of his marked executive ability should be rewarded in substantial shape. The testimonial to the Westinghouse Electric Company was not less graceful and fitting. The company's liberal contribution to the funds of the Association enabled it to catch up in the publication of its proceedings, and to present a healthy balance sheet.

It was a good idea to secure a photograph of the delegates before leaving, with the Electric Club as a background. An interesting memento is thus obtained of a pleasant gathering and of the hospitality that found its centre at the Club House.

Allegheny City, Pa.—Specifications have been approved by the sub-committee on gas for 45 electric-light towers with 3 to 6 lights on each; 85 single pole lights and 1,500 incandescents for the city hall, engine houses, etc.

Brush Carbons.—The Brush Electric Company, Cleveland, O., report that their carbon business is larger than ever before. They have shipped within the last month or two, eight or ten solid car loads of carbons to different portions of the country.

Buffalo, N. Y.—The Brush Electric Light Company of Buffalo, N. Y., are increasing their electric light plant. They have recenty ordered from the parent company two 65-light 2,000 c. p. dynamos with lamps. This company is now burning, including the above dynamos, 1,300 arc lamps and a large number of incandescence.

The Graphophone in the West.—A company of Western men, with Hamilton S. Wicks, of Kansas City, at their head, has secured a contract with the syndicate controlling the Edison-Bell graphophone for all rights within the territory west of the Mississippi and east of the Rocky Mountains. Offices are to be established and the instruments introduced into the leading cities of that district by Oct. 1.

Electricity for Writers' Paralysis.—In one of the broad windows of the recording department of the office of James Bond, clerk of the superior court, is a small electric battery. It is used by the recorders for the relief of the cramp of the muscles of the hand which follows long continued and steady use of the pen. The relief is instantaneous, and the clerks who formerly were compelled at times to stop work for several days on account of swelling and contraction of the muscles of the hand now take a few gentle shocks of the electric current on the slightest approach of stiffness. They return to work at once, entirely relieved, and continue without inconvenience. Nearly every one of the score of clerks receives benefit from the electric current, and the battery is regarded as an indispensable fixture of the office.—*Baltimore Sun.*

Bell Telephone Output.—The instrument account shows gains in the output and a reduction in the instruments returned. For seven months there was an increase of 4,216 in instruments held by licenses. The income gains faster than the output of instruments. The latter is as stated below:

Month to Aug. 20.	1888.	1887.	Increase.
Gross output	3,694	3,523	161
Returned	1,760	3,353	*1,593
Net output	1,934	180	1,754
Since Dec. 20.	1887-8.	1886-7.	
Gross output	37,740	36,541	1,199
Returned	14,646	17,663	*3,017
Net output	23,094	18,878	4,216

*Decrease.

Eighth Meeting of the National Electric Light Association.

The eighth semi-annual meeting of the Association was held at the Hotel Brunswick, New York City, Aug. 29, 30 and 31, 1888.

The following gentlemen were in attendance during the convention:

AUBURN, N. Y.—F. C. Simpson.

BALTIMORE.—F. R. Colvin, D. E. Evans, W. H. Harding, P. O. Keilholtz, F. W. King, James Larkin, J. Frank Morrison, Norman McCarty, Arthur Steuart, Gilbert Wilkes.

BOSTON.—P. H. Alexander, M. H. Barker, F. J. Boynton, F. E. Clark, Walter P. Clark, W. F. Collins, H. B. Cram, D. W. Dunn, C. L. Edgar, H. H. Eustis, A. V. Garratt, D. Killicutt, Dr. A. F. Mason, F. E. Pettingell, J. N. Pratt, C. M. Ransom, Frank Ridlon, R. F. Ross, L. Schaefer, L. Schlegelmilch, F. Swift.

BROOKLYN, N. Y.—J. Ferguson, H. J. Jaeger, Wm. Hochhausen, E. R. Knowles, Edward F. Peck, A. H. Ryder, W. D. Sargent, B. J. Warner.

BRUSSELS, Belgium.—M. F. Van Rysselbergbe.

BUFFALO.—S. F. Eagan, C. R. Huntley, F. B. Rice.

CHICAGO.—J. L. Barclay, G. L Beetle, C. A. Brown, H. D. Brukins, F. E. Degenhardt, F. De Land, C. K. Giles, F. W. Harrington, — Huston, W. A. Kreidler, H. E. Longwell, G. A. Mayo, D. P. Perry, J. H. Shay, A. K. Stiles.

CINCINNATI.—E. V. Cherry, A. R. Foote, H. G. Rich, G. T. Woods.

CLEVELAND.—W. H. Boulton, K. D. Bishop, C. S. Britton, C. C. Curtiss, S. E. Cox, J. B. Crouse, E. B. Gethin, H. E. Hayes, W. H. Lawrence, J. S. Scoville.

COUNCIL BLUFFS, Ia.—T. Officer.

DANBURY, Conn.—E. T. Wightman.

DECATUR, Ala.—W. H. Fleming.

DETROIT, Mich.—W. H. Fitzgerald, Fred H. Whipple.

ELIZABETH, N. J.—H. W. Pope.

ELMIRA, N. Y.—F. H. Leonard.

FALL RIVER, Mass.—Geo. Woodcock.

FORT WAYNE, Ind.—M. M. M. Slattery.

GREENPORT, N. Y.—W. F. Hammond.

HARRISON, N. J.—B. F. Card, Theo. Mace.

HARTFORD, Conn.—G. A. Johnson, H. H. Johnson, F. G. Waterhouse, C. K. Weed, H. M. Linnell.

HOUGHTON, Mich.—J. R. Dee.

JACKSONVILLE, Ill.—M. B. Ayer.

JOHNSTOWN, N. Y.—J. H. Cross.

KANSAS CITY, Mo.—E. R. Weeks.

LEADVILLE, Colo.—H. B. Slater.

LOWELL, Mass.—J. Y. Bradbury, J. Markland.

LYNN, Mass.—G. F. Curtiss, M. J. Wightman.

MANCHESTER, Conn.—W. A. Authony.

MCKEESPORT, Pa.—J. H. Reiber.

MALDEN, Mass.—A. E. Bliss.

MASILLON, Ohio.—C. A. Gates.

MONTREAL, Canada.—W. J. Morrison, H. S. Thornberry.

NASHUA, N. H.—W. D. Cadwell.

NASHVILLE, Tenn.—R. L. Morris.

NEWARK, N. J.—C. Baker, Jr., C. McIntire, C. H. McIntire.

NEW BRITAIN, Conn.—T. H. Brady, L. C. Whitney.

NEW HAVEN, Conn.—F. L. Bigelow, S. J. Fox, Dr. Leonard Waldo.

NEW ORLEANS, La.—S. J. Hart.

NEWPORT, R. I.—W. Hood.

NEWTON, Mass.—H. H. Cutler.

NEW YORK.—H. C. Adams, M. F. Adams, P. C. Ackerman, A. Arango, C. H. Barney, Geo. W. Blanchard, W. W. Biddulph, C. H. Bogle, L. R. Boehm, C. R. Botsford, W. C. Brown, J. H. Bunnell, J. R. Burdick, A. W Butterworth, J. Calisch, W. M. Callender, W. L. Candee, E. W. Carritt, D. Chalmers, J. C. Chamberlain, W. A. Childs, C. W. Childs, C. A. Cheever, A. C. Chenoweth, E. P. Clark, R. Coleman, Addison Conkling, F. B. Crocker, W. F. Cullen, J. R. Curtair, H. N. Curtis, Henry C. Davis, M. De Lamater, P. A. Dowd, D. W. Edgecomb, Jarvis B. Edson, J. F. Eliot, C. J. Field, G. D. Fuller, R. R. Gallaher, E. F. Gennert, D. L. Gibbens, W. A. Giles, M. B. Gisborne, J. W. Godfrey, M. W. Goodyear, P. R. Green, G. H. Guy, B. F. Hamilton, John H. Hapgood, H. McL. Harding, Jacob Hess, R. S. Hubbell, D. M. Hurlbut, Walter T. Hunt, W. J. Johnston, H. Kearney, J. F. Kelly, W. H. Kelly, F. E. Kinsman, C. J. Kintner, J. Lane, Theodore Larbig, G. W. La Rue, Z. Latshaw, A. B. Laurence, E. A. Leslie, H. F. Lufkin, E. T. Lynch, Jr., Frank A. Magee, O. E. Madden, George T. Manson, T. C. Martin, R. W. Martin, Thos. McCoubray, Jr., W. H. McGrath, C. McLaughlin, J. P. McQuaide, T. J. McTighe, R. C. Moffatt, J. J. Moore, Dr. Otto Moses, Theodore Moss, B. B. Nostrand, J. F. Olcott, F. Jarvis Patten, A. H. Patterson, J. M. Pendleton, C. L. Perry, Geo. M. Phelps, W. P. Phillips, J. C. Pierrez, Chas. W. Price, Frank Pope, Ralph W. Pope, A. H. Rennie, H. Richmond, W. A. Rosenbaum, A. Rosenfeld, R. W. Ryan, E. M. Sanderson, C. A. Schieren, C. W. Schieren, W. J. Sefton, J. A. Seely, A. C. Shaw, A. Shedlock, F. Skinner, C. D. Smith, T. T. Smythe, T. W. Sprague, A. F. Stanley, Geo. H. Stockbridge, Frank G. Stone, C. E. Stump, Wm. F. Swift, J. B. Taltavall, C. A. Terry, C. E. Truex, P. H. Vander Weyde, Major Walker, B. R. Western, Joseph Wetzler, S. S. Wheeler, G. L. Wiley, F. H. Wilkins, C. H. Wilcox, J. Williams, E. W. Wilson, C. Wirt, George Worthington.

NIAGARA FALLS, N. Y.—B. Rhodes.

NORTH ATTLEBORO, Mass.—T. W. Dillon, H. M. Daggett, Jr.

OREBRO, Sweden.—James Wenstrom.

PARIS, France.—B. Abdank-Abakanowicz.

PAWTUCKET, R. I.—S. G. Stenck.

PATERSON, N. J.—Mr. Halsey, J. F. Noonan.

PHILADELPHIA, Pa.—David Brooks, H. A. Cleverly, A. J. De Camp, A. L. Dunton, J. Garnett, R. O. Heinrich, Carl Hering, E. J. Houston, C. C. King, M. D. Law, A. F. Moore, E. A. Scott, J. R. Simpson, T. Carpenter Smith, W. F. Smith.

PITTSBURGH, Pa.—E. G. Acheson, G. H. Blaxter, H. M. Byllesby, S. A. Duncan, R. D. McGonnigle, M. M. Mead, Geo. F. Porter.

PLAINFIELD, N. J.—A. V. H. Moore.

PORTLAND, Me.—J. English.

POUGHKEEPSIE, N. Y.—J. M. Candee.

PROVIDENCE, R. I.—H. N. Fenner, M. J. Perry, R. T. Robinson.

RAHWAY, N. J.—Henry Carman.

ROCHESTER, N. Y.—G. A. Redman.

RUTLAND, Vt.—M. J. Francisco.

ST. JOHN, N. B.—A. A. Knudson.

ST. LOUIS, Mo.—R. D. Russell.

SYRACUSE, N. Y.—A. P. Seymour.

TAUNTON, Mass.—D. L. Mitchell.

TOKIO, Japan.—Hasegara Fee.

TRENTON, N. J.—F. Angell.

TROY, N. Y.—J. C. Minahan, R. J. Pratt.

UTICA, N. Y.—E. G. Bernard, F. G. Cartwright, H. S. Vanderbois.

WALTHAM, Mass.—F. H. Leonard, E. A. Marsh.

WASHINGTON, D. C.—F. E. Royce.

WINDSOR, Conn.—M. E. Baird, W. C. McIntire, A. D. Newton.

WILMINGTON, Del.—J. S. Hoffecker.

WOBURN, Mass.—G. R. Lean.

WORCESTER, Mass.—A. M. Smith.

YOUNGSTOWN, O.—C. Coombs.

The Convention was called to order at 12 M on Aug. 29 by the President of the Association, Mr. S. A. Duncan, of Pittsburgh, Pa., who addressed the Convention as follows:

Gentlemen of the National Electric Light Association in convention assembled:

When this association, after six months of existence, last met in this great city of New York, three years ago, but sixty gentlemen were present. To-day we are over three hundred; in other words, the attendance has increased fivefold. I am, therefore, able to congratulate you upon the growth, prosperity and stability of this organization, in whose welfare we are all so deeply interested, and in whose commercial usefulness we all take pride, for we have all had a hand in its making. And I am also able to congratulate you upon that which is more important than numbers—and that is the fact that this association is rapidly becoming the centre of all matters pertaining to the arts which depend on the application of powerful electric currents, and that its proceedings are watched with growing interest by not only the whole electrical public of this country, but also abroad. It is sometimes interesting to notice how we are regarded beyond those limits which properly come within our jurisdiction; and I would call your attention to a fact—which is certainly not uncomplimentary—and it is this: Although, during the early days of our history, the technical papers abroad paid no further attention to our proceedings than to ridicule them, yet of late, and more noticeably for the last six months, almost every paper which has been read before this association has been copied by the leading electrical papers all over the world. And can there be a stronger indication of the growth of the industries which have been fostered by this association than the fact that they support in this country no less than eight journals devoted exclusively to electrical matters? This prosperity, upon which we have been mutually congratulating ourselves, has been due not only to the commendable efforts of the rank and file of our membership, but also, in no small degree, to the good judgment, perseverance, untiring energy and marked ability of our honored past president, Mr. J. F. Morrison, and the able committees which have assisted him in administering the affairs of this association.

But it is of more importance to us to consider the present state of the industry. From time to time statistics as to the amount of electric light apparatus in use in this country have been presented to the association. At Pittsburgh, it was estimated that there were no less than 4,000 isolated plants and central stations, operating 175,000 arc lights and 1,750,000 incandescent lights. To these figures, we may now add that there are 1,351 new isolated plants and central stations, operating 35,201 arc lights and 392,944 incandescent lights, of which I have a detailed record. By adding this increase to the figures of six months ago, we find that there are now 5,351 isolated plants and central stations, and there are burning every night in the year in the United States no less than 192,500 arc lights, and 1,925,000 incandescent lights. We may also add that there are 459,495 horse-power of steam engines devoted to electric lighting. Figuring this in coal consumption, it can be demonstrated that, in the year 1888, enough coal will be consumed in the United States, for electric lighting purposes, to make a solid column 100 feet square and over a mile high. It may be here parenthetically remarked that there has been an increase in the capitalization of the electric light companies of the United States in the last six months of not less than $42,210,100.

But we have not yet touched upon the great industry of the electrical distribution of power. There are at the present time (of which we have a record) 34 electric railways completed and in operation in the United States, having an aggregate of 138 miles of single track, and operating 223 motor cars, and utilizing 4,180 horse-power for stationary engines. There are, also, now in process of construction 49 other electric railways, aggregating 189 miles of single track, which will operate 244 motor cars, so that at the present time there are constructed and being constructed 83 electric railroads, aggregating 327 miles of single track and operating 467 motor cars. In this connection it must be remembered that there are 39 other electric railroads incorporated, which have not yet begun construction. It is also estimated that the electric cars now in operation in the United States will carry in the year 1888 no less that 17,045,500 fares. It can be better imagined than estimated what will be the ultimate outcome of an industry which has arrived at such a degree of development in three years.

In view of the difficulty of compiling statistics on such small unities, it has been impossible to collect reliable information relative to the stationary motor business; but we know that at the present time it has stimulated capital to such an extent that there are single factories employing no less than 1,500 hands each in the manufacture of electric motors, and, at no far distant day, all large cities will have their power stations of several thousand of horse-power each, distributing energy throughout every ramification of industry. So rapid a development of this new industry into gigantic commercial proportions should be an admonition to the electric light companies now in the field to reap the harvest which is white to their sickle and not to wait for competitors to come within their field of operation, in the shape of power stations; for these people, once established, will reach out and take in a large portion of the electric lighting business.

The present meeting of this association gives promise of being one of the most interesting so far held. The report of the secretary and treasurer shows the association to be in a gratifying financial condition, there being a balance of a thousand dollars in the treasury after the payment of all bills, and the membership is steadily increasing. The proceedings of the last four conventions have been printed and furnished with a thorough cross index, and each member has been provided with a copy. The admirable way in which the proceedings have been printed reflects credit upon the executive committee, under whose direction it has been carried out, and the carefully compiled cross index, and the accurate technical proof reading of the publishers of "Modern Light and Heat," deserve creditable mention. The report of the executive committee through its chairman, Dr. Otto A. Moses, and the reports, of the several committees, together with the following papers, should command the closest attention of the entire convention.

The difficulty of obtaining reliable statistical information in regard to the various electrical industries, and also for the purpose of giving continuity to the whole association from one convention to another, warrants the president in urging upon the association the necessity of establishing a permanent office which shall be a repository of all information relative to the allied electrical industries and a means of intercommunication between its members, and from which the officers and executive committe can administer the affairs of the association. This office should contain a good reference library of electrical works, complete files of all domestic and foreign electrical and other electrical journals, and the repository of the archives of the association. It should be a place where every member of the association should feel at home, and where he would naturally go for any electrical or other information that it contained. A very slight increase in the running expenses of the association would maintain such an office, and, when established, it would, from its innate value, increase the membership of the association to such an extent, that the running expenses of such an office would take care of themselves.

Does not this association, having, during its years of growth, spread its roots widely through the electrical industry of this country, stand upon the eve of becoming much more widely influential than ever before by carrying out the suggestion of Mr. Frank Ridlon, at the convention in this city three years ago, which was further elaborated by a committee specially appointed for that purpose, which reported, through its chairman, Dr. Otto A. Moses, at the Detroit convention, and was still further advocated by Mr. Arthur Steuart, Mr. E. R. Weeks, Mr. A. J. DeCamp, at subsequent conventions—namely, the establishment of a permanent headquarters as already sketched out?

Gentlemen, in conclusion I will say that in no way can you better assist the chair, in the discharge of his duties, and in no way can you more aid in making this convention a thoroughly successful one, than by a constant attendance at its sessions. I know that the more than generous hospitality in the shape of various entertainments, as mapped out by our New York friends, may tend somewhat to distract your minds from the serious business for which you have assembled, but I also know that you can find ample time, not only to accept of their hospitality, but to give to this convention your entire time and attention during its sessions.

President Duncan then introduced Mayor Hewitt, who said:

My duty on this occasion is as easy as it is agreeable. I am here to bid you welcome to the city of New York and to tender you such hospitality as the Mayor of this city has it in his power to tender. To distinguished strangers I think the usual form is to give the freedom of the city in a gold box. If you will leave out the gold box I can tender you the freedom of the city, but exactly what it is I do not know. (Laughter.) To those who are strangers here I trust it will be found exceedingly pleasant and highly profitable. I gather from the remarks of your President that you are here to take stock of what you know about electrical science and its application to useful purposes. I think it will be easier for you to ascertain how much you know than to find out how much you do not know about this subject. (Laughter and applause.) And in the last part of that inquiry I am in entire sympathy with you. (Laughter.) When I have professed, as I have had to do on various occasions, that I did not know anything about this subject, it has been received with incredulity, but you who do know something about it know that I am exactly right. When you reflect upon what you have to do, you must be rather appalled at the magnitude of the contract. This convention must strike the average uninstructed mind pretty much as a meeting of astrologers in the ante-Christien era would have done throughout the Orient, or a convention of necromancers and magicians during the Middle Ages. You deal with something to the popular mind very mysterious, almost incredible. You have already performed wonders which even the most intelligent men can only regard as miraculous. You stand today pretty nearly in the condition in which Watt one hundred and ten years ago must hove found himself when he produced the first perfected condensing engine. Crude forms of engines had been in use doing more or less effective work prior to his day; but in 1776, the year of our emancipation from foreign control, Watt produced the first real working machine. Now, what has been done in one hundred and ten years? There are still living in the world men who were alive when the first engine began to do its work. Could any man if he had been gifted with the power of prophesy—could any man have forseen the transformation which the whole world would undergo in a century from the time of that great invention? Can you conceive of the world without a steam engine? Could the population which now inhabits the globe survive for sixty days if the steam engine were withdrawn from use? Would civilization have even an apology for existence to-day without the steam engine? Now, gentlemen, looking back you can see how the application of one great motive force can transform the face of the universe. Looking forward, is there a man here who can tell us what this new electrical force is going to do for the world? Can any man say how it is to be enriched, how it is to be purified, how it is to be exalted from the depths of poverty and suffering in which in many parts it is plunged? If electricity, like air and water, could be made free to the hand of labor or to the wants of men, could be turned on by tap, so to speak, either without charge or at a merely normal cost, don't you see that all monopoly would cease to exist? For monopoly consists in nothing but the power to appropriate force to personal and private use. If all force and all power were made free to all men, isn't it apparent that that the inequalities of fortune, and almost all the evils of which mankind complain, would disappear? Is there anything more astonishing in this prospect than in the retrospect which you can all take of the work that has followed the introduction of the steam engine? I used to be told when I was at school—I don't know how it is now—that the earth is a great magnet. You may have changed all that, but I hope you have not, for I do not want to lose what little I do know. (Laughter.) We used to be told it was a great magnet, and that it revolved on its axis once in 24 hours, and that it was 25,000 thousand miles in circumference. Now, that strikes me as the definition of a mighty large dynamo. If a great magnet 25,000 miles in circumference is put in revolution so as to turn on its axis once in 24 hours, from what I have seen of the dynamo it strikes me that there must be a vast incalculable fund of electricity produced by that operation. (Applause.) I know nothing about it, I may be talking nonsense, but at the same time, if that be true, and if it be true of the whole planetary system, and of the whole universe of the Divine Architect, what a vast fund of unappropriated power there is for mankind in the future; and knowledge is power and power is wealth, and wealth, which is free to all who have got the brains to take it, is the benefaction of mankind, and the opening of the gates of the millenium, which, if we are ever to see it, will be accomplished by you gentlemen and those who will come after you, for this is the only course that I am able to say by which the goodness of God and the bounties of divine providence can be distributed with a free hand to all the world and to every man, woman and child within its bounds. (Applause.)

Upon the borders of this land of dreams we stand. You are slowly raising the curtain of the future. I shall not see the drama played out; but there are men in this room who will live to see society transformed by this new agency, for it is a curious and suggestive fact that all moral forces and all moral questions find their final resolution in the facts and laws of physical nature. There is where you come at last. If this world is a better world

to-day, a richer, a happier, a more enlightened world to-day than it was a hundred years ago, it is due mostly to the steam engine and its applications. If it is to be, as I believe it is to be, a better world, year by year and century by century, it will be due to the discoveries and applications of electrical force, or of some other force which possibly may be hereafter ascertained and developed: but to-day we must call it by the name which you and I know it by—the electrical force.

Hence I bid you welcome to New York. I am glad to see you. You are benefactors. You come to two millions of people with a gospel. You are the apostles of a new industrial dispensation. You are distributors of this overgrown wealth which you hear is in few hands in this great city. It cannot stand your attacks. It has withstood the preacher and the moralist and the philosopher, but it will not stand against the scientist who discovers the laws of nature and who makes them free to all who drink at the fountain of science. (Applause). Yes, you will revolutionize the world; you will regenerate society; and it is none the less to your credit that while you are doing it you are making your living and getting an honest compensation for your labor (Applause), for it is a law of Divine Providence that utility and beneficence shall march hand in hand down the highways of civilization. They are bound together by a Divine law, and you are the executors of that law when you open new fields of discovery, new forms of value, new applications to useful purposes. Of course we bid you welcome, and we bid you welcome because we feel that we are so ignorant and need your help. We are engaged in this city in undertakings which require from you your honest and best judgment. We send messages by wire through our streets. We light those streets by conductors perched upon poles through the streets. We talk through a network of wires so thick overhead that often the sky is obscured. They are not pleasant to look at, but they are indispensable in the present state of knowledge, to the business of society. (Applause.) The man who would disturb them until something better is found out and proved to be found out would be a barbarian. (Applause.) Still, like the Mayor, they have got to go. (Laughter.) But the Mayor is too old to go at a 2:40 gait (Applause), and he likes to see his way clear before he takes a step. Now, in order to clear up this matter a little for you who know so little, as I have said, about this subject, and I knowing so much, let me say that this much seems to have been found out at some cost to somebody—I do not know who—that it is quite feasible to put under ground all the telephonic and telegraphic wires, and in fact all wires which carry low tension currents. I suppose that is now demonstrated, and I trust that in a very short time this city will be relieved from the unsightly telegraphic wires, telephonic conductors and from any modes of diffusion for incandescent lighting which may still remain above ground. I suppose that is all feasible. The question what to do with the high tension currents remains. First, we ask you to tell us—at least I ask you to tell me, because there are some people here who know more than I do—whether a satisfactory mode of cable transmission for high-tension currents underground has yet been devised. I understand that a cable for the Brush Company is about to be laid in one of the conduits which have been constructed in Broadway, and I suppose that will test the question as to the feasibility of the transmission of high-tension currents practically and economically, because there is no sense, you know, in things that do not pay. If it is too dear, we have got to give it up. (Applause.) I suppose that that will test the question, and I am very glad of it. I have been censured—possibly by you electrical gentlemen; I do not know—very much, for not having taken steps to coerce all these lighting companies into putting cables underground until that question was settled. Well, I am no longer a young man. I have had a long experience in life. I have done a pretty large business in my time. I have had to deal with very difficult problems, and I have learned that the part of wisdom and of true speed is to go slowly and to ascertain your facts and get your knowledge, before you undertake to re-construct the universe. I have been very desirous that this matter should be tested—this question of transmission of high tension current underground—at the earliest possible moment. And I congratulate you on the fact that it is going to be tested by a responsible company; and, until it is tested, let me say to you, frankly, that if it were in my power to compel the other companies to do this thing now, to-day, I would not do it. (Loud applause.) I should look upon myself as an everlasting fool (laughter), who ought to be consigned to eternal seclusion in a madhouse, if I did such a thing. But I hope it will succeed, and, if it does succeed, no public officer will be more prompt than I shall be in compelling every electric light company to respect the intention of the legislature when it confided this great work to four men who did not know anything about what they were going to do. (Applause.) The Legislature evidently recognized the fact, which you recognize and I do, that what we don't know about electricity is a good deal more than what we do know about it, and so they took some men who were supposed to understand politics if they did not know anything else. (Applause.) I speak thus frankly, because I am one of the four men. (Laughter and applause.) I should be the last man to cast any imputations upon my colleagues who have charge of this most interesting and important public work; but I think that we shall all of us be wiser—my colleagues as well as myself—after a little more experience has been gained upon the subject to which I have referred.

Now the second question is this: When the cable is underground and works successfully, will you kindly inform me and the public, through whom I communicate with you, whether a satisfactory system of distribution has been discovered and put in practice? It is one thing to put the current underground and another thing to get it out so that there may be lights. Now, I know nothing about it; I have simply made inquiries of every intelligent electrician that I could meet, and up to this time I have not been able to ascertain that there is a satisfactory mode of distribution. Now, you know whether there is or not. If you should say to me, after a discussion of the subject that there is, I should accept your judgment as final, because you embody all that there is known of this abstruse subject, and if you, by your resolution, say that there is a proper and comprehensive system of distribution so that the evils that are complained of will be abated, and that there will be absolute safety in the distribution, then my mouth will be closed and I shall act upon your judgment; and that is the reason why I have come here chiefly to-day, not simply to welcome you as strangers and guests from abroad, but to ask you to consider this subject coolly, dispassionately, intelligently, and give us the results of your discussion, so that we may act coolly, dispassionately and intelligently in carrying out the law.

Now, as to the matter of danger. The newspapers have teemed during the last year with sensational articles pointing out the great danger of the present system. Remember, I do not like the present system. I regard it as—I was going to say—barbarous. The streets should not be defaced. We should not have these wires running about. But let us get at it on proper grounds—æsthetic grounds, if you will, scientific grounds, economical grounds—any other grounds than prejudice and sensation. Those I take no stock in, and I will never allow myself, and I trust no man who is a lover of truth will allow himself, to be dragooned by the newspapers into doing what he believes to be wrong. Now is this dangerous, will you kindly tell us? I thought it was exceedingly dangerous; I went into office with the impression that every man who went out in a street lighted by a high-tension current took his life in his hands, and I was as anxious as anybody to get them removed; but when it became my duty to look into the matter I found that in proportion to the amount of work done, measured by our friend, the President's, column of coal, if you like, or by these other things that you call ohms and volts and which my colleagues are flinging at the common council pretty much as that distinguished millionaire at Saratoga turned out his gems among the boys the other day,—(Laughter.) I am sorry I was not there by the way; I was about fifty miles away. When I heard of it I made tracks, but I could not get there. Perhaps my colleagues got there. (Laughter.)—well, I found, measuring it by the work it was doing and ascertaining the accidents that occurred, to my astonishment I found that we had more accidents daily from the horses in the streets—infinitely more: that we had more accidents with steam engines; that even the building of houses in the city caused more deaths every year—infinitely more deaths in this city than this particular agency. I was therefore driven to the conclusion that, considering the work it was doing, comparing it, if you like, with the illumination by gas, that it was positively safer, just as the railway had proved to be safer than the stage coach, and the stage coach probably safer than walking for the number of people carried. I found that with all the difficulties with this thing, the results seemed to show that it was absolutely safer than any other useful agency at work in this city. I may be wrong, but that was the conclusion to which I was forced. But then when I investigated the cause of the accidents I discovered that they were not due to anything that was inherent in the transmission of the current overhead, but it was rather due to two causes, either the carelessness of the company in inspecting its installation and keeping it in good order, or in the carelessness of the person who came in contact with it—one or the other. Now, there is no excuse for the companies, not the slightest. They undertake to render a public benefit; they are paid for it; they undoubtedly ought to see that their plant is in the most perfect order possible, and any company that neglects to keep its plant in proper order is, of course, liable to the penalties of the law, and I would be the first to have the officers of such a company indicted, if I could. But I take it that the duty has been on the whole pretty well performed, because the accidents have been so few. They have been very few, indeed. I believe that in this city there are but four cases of death in consequence of any difficulties with the wires themselves.

Now, under the circumstances, the thing that would seem to be wanted—and I think it will be wanted when you come to your plan of distribution just as much as it is wanted now—is a thorough inspection of the means by which the light is made available to the public above the ground, and that inspection should in the first place be made by the companies themselves, who have the greatest interest in the matter and the largest duty to perform, and I fully agree that the public, who have a great interest in it, should also have thorough inspection, and the reasonable rules and regulations which may be adopted by the body that is charged with the custody of this matter should be implicitly obeyed, and any violation of them ought to be severely punished. But I would like you to consider the whole question, not merely the distribution; but if you come to the conclusion that no adequate mode of distribution has been found that will dispense with the present mode, then that you will consider and advise us how we can make it safer to the public, and thereby more economical and useful to the companies who supply the lights. These are questions of such paramount interest in this city that your presence here is most welcome. I trust you will give us the benefit of your knowledge, and when you do not know I hope you will say so, and confess your ignorance like men, for that is what I have been doing now, and what I intend to do so long as I am mayor. Gentlemen, you are welcome to New York. (Applause.)

Mr. W. H. Harding, the secretary and treasurer, then presented his report, showing a net membership of 189, being a notable increase, and funds in hand of about $1,000. Reports were accepted.

On motion of Mr. C. A. Brown, of Chicago, it was resolved that a committee of five be appointed to select the place for the next meeting of the convention of the Electric Light Association and to report to this convention. Before the close of the session, the chair appointed Messrs. Brown, Weeks, Officer, De Camp and Stanley members of the committee.

Mr. T. C. Martin, chairman of the committee on testimonials, then presented, in the name of the association, to Mr. J. F. Morrison, the resolutions passed at the Pittsburgh meeting in regard to that gentleman's distinguished services as president for three years. The resolutions were in a leather case and very handsomely engrossed.

MR. MORRISON: This is perhaps the first occasion since my acquaintance—my intimate acquaintance with the gentlemen who composed the National Electric Light Association, when I have been glad that I am not very well. I find at this very agreeable surprise party which you have prepared for me, and which it is a wonder has been kept quiet where so many men knew it, that I am almost unable to talk, and you know what a terrible thing that is to me. I accept the gift which you have presented, and I think it is needless for me to say to you, and I think you will believe me when I say, however, that I fully appreciate the spirit in which it is tendered. At the start this association required perhaps different material in its presiding officer from that which it requires to-day. I believe that for the first year I filled the bill fairly well. I do not flatter myself very much. I believe that after the first year a man more bending and more conciliatory than I am, perhaps, would have filled the bill better. Through your kindness and indulgence I was continued in that honorable office until last February, when you kindly permitted me to retire. For that and the beautifully engrossed resolutions expressed in such kindly terms, I now thank you. I am not out of the service, by any means. I hold the honorable position of a member of the executive committee, and I do not propose to be a deadhead in that or any other part of this enterprise. I am at your service now, gentlemen, as I was before, and I expect to remain in the service so long as the National Electric Light Association exists and I live. I thank you for the compliment. (Applause.)

THE PRESIDENT: The next business in order is the report of the Chairman of the Executive Committee. I see he is now present. You will hear that report.

Dr. Moses made a brief oral report, which was received.

THE PRESIDENT: The next business in order is the report of the Committee on the Constitution, of which Mr. A. F. Mason, of Boston, is Chairman.

Mr. Mason then presented the report in the shape of a revised constitution. It was decided to discuss the subject on Thursday afternoon.

THE PRESIDENT: The next business is the report of the Committee on Insulation and Installation of Plants. Prof. Elihu Thomson and Dr. Moses are on that committee.

DR. MOSES: Gentlemen, I appear here on behalf of the Chairman of the Committee on Insulation and Installation, Prof. Elihu Thomson being the chairman. I received the following letter from him, which causes me to speak for him:

LYNN, Mass., Aug. 25, 1888.

Dr. Otto A. Moses, Hotel Brunswick, New York:

DEAR SIR: It will be impossible for me to make any formal report of the work done by the Committee on Insulation and Installation of Plant. If you will prepare a brief statement of what was done at the meeting, and attach the inclosed schedule of data to be asked for, I think that it will be all that can be done under the circumstances. This might be presented as an informal statement of what was being undertaken by the committee, and the association might then be called upon for the preparation or printing of a number of such blank schedules, to be sent to the various electric light companies. The spacing in the schedule will need to be modified so as to give more room in some places and less in others for the answers to the questions. I am hoping to be able to run down to the meeting, but I may not be there at the time when the report may be in order, and will therefore look to you, if present, to say what you can of the progress made. Some time ago I sent a copy of the schedule to each member of the committee, but have thus far received but two acknowledgements. Yours truly, ELIHU THOMSON.

Dr. Moses then stated the work that the committee had done in preparing the schedule circular.

MR. E. R. WEEKS, Kansas City: I move that the report be received and filed, and the committee continue. The motion was seconded.

MR. MORRIS, Nashville: I move that the report be read. Let us have something to act on. We do not know now whether we want that committee continued or not.

DR. MOSES: I have no authority to submit a report, but only to act as the mouthpiece of apology for the chairman, who is not here. His report you will have to gather as you may from his letter which I have read. The questions here, which are the results of memoranda made by all the members of the committee, I will read, if you like, but it will take a little time—about five minutes.

Dr. Moses read the schedule submitted by the Committee, which requires a number of answers to questions as to the disposal of wires in use and their behavior under a great variety of circumstances.

MR. MORRIS: Mr. President, knowing that a paper on the insulation of wires was to be read, was one consideration which led me to come here, so as to learn something about that. My company has under consideration the reinsulating of its entire system, and we do not know what is the best. It seems to me that the solution of a good insulation is largely the solution of the underground question, and I must confess my very great disappointment with the report of the committee on that subject. I very much appreciate the delicacy the committee would have in reporting this wire or that wire—this manufacturer's wire or that manufacturer's wire; but at the same time it is a question that ought to be taken hold of and there ought to be some answer to that question. I think if those questions were printed and sent out the answers that you would get would be so small in number that they would practically be of no benefit in arriving at any proper conclusion. I am satisfied that the managers of stations are not going to take the trouble to answer those questions, and practically you will have accomplished nothing. We can only receive the report and discharge the committee and appoint a new one or continue them. But I cannot refrain from expressing my disappointment in regard to that report.

After a few remarks by Dr. Moses as to the hard work done, and its delicate nature, Mr. Morrison said that until they did somehow get at definite data as to wires and cables—no matter whose—they would be groping in the dark.

MR. MASON: I do not propose to be held back from speaking on this motion by any fear that any one will say I tried to boom a wire. I do not believe there is a representative of any company who would degrade himself and abuse the privilege of this floor by any such course, and I do not believe anybody here will suspect me of any such intent. The President will remember that the original motion made two years ago for the appointment of a committee on insulation I had the honor to propose, and since that time I have felt moved to press the continuance of the committee or the appointment of new committees. So far the work has not been satisfactory, as the gentleman who presented this quasi report to-day has stated. The results have been nil so far. Personally I do not believe that all the laboratory experiments that these learned gentlemen and this committee could have made would have been worth one farthing to the members of this association. I do not believe that laboratory experiments upon insulation give us any reliable practical facts. Furthermore, in talking with gentlemen who are of very high standing as experimenters I learn that such is their opinion. They allow that they cannot make a series of experiments, one exactly duplicating another. So much for that. I think I may say that I fully agree with the gentleman from Nashville in his opinion that we should get but very few other answers to those questions if he sent them out; and if we got them, what is the value of each series of answers? First it depends on the character of the man who writes, upon his ability, upon his frankness, upon many other factors, and the value of those factors cannot be estimated by the committee. I cannot conceive how we are going to reach the end we want through any such questions. I want to say right here and now, that, anxious as I am for the facts that are aimed at by those questions, and earnestly desiring as I do that the whole electrical fraternity shall be acquainted with the facts regarding all insulations—among others, the fact that no one insulation is the best for all cases—yet I do say I do not believe it is a wise use to which this association may be put—to quote again the words of Mr. Morrison—to boom anybody's goods. I do not want the goods of which I have the honor to be the proprietor to be boomed by this association. I do not believe any other gentleman here wants these goods to be boomed in that way. Mr. President, I shall run the risk of some unkind person saying: "He did not want his goods tested thus," and I put myself on the good nature of my brethren by making this motion that this report be accepted and the committee discharged.

The motion was seconded.

THE PRESIDENT: The pending motion is an amendment offered by Mr. Mason that the report be received and the committee discharged.

MR. MORRISON: I object to any such motion. I object to the closing of any channel of information for this association. I do not think that the shutting off of any source of information that may have been opened in times past will be of benefit to the association. I am glad to receive information from Mr. Mason or from any other gentleman engaged in his line. We all know what an honest—I would say a modest—set of men the wire men are. I would never accuse them of being very honest, but modest. But for my own sake and the sake of the other members of this association I hope the gentleman's motion will not prevail. That committee is composed of the most intelligent men in the various lines of business which they follow. If you discharge them, you are at the mercy of Mr. Mason and the wire men. If you continue the committee you have got an intelligent body of reference, to whom you can refer those matters. And if Mr. Mason comes to me and says, "I have got the best insulated wire in the world," and gives me his samples, I can go to the committee and say Mr. Mason claims such and such properties for his goods, and then these despised laboratory experiments come in very well, and you can take these to a chemist and he will tell you whether the constituent parts of the insulator

are such as will carry out the guarantee of the gentleman who offers the wire for sale. I ask that the gentlemen of this association will not vote to discharge that committee. It is a tough job to move to receive and approve a half finished report like the ones the committee has sent in for two or three years, but it is better than no report at all. They may wake up to the fact that the information is of importance to them, and take enough time from their slumbers or pleasures to make up a report that is free from blanks and queries. I hope you will vote down the substitute and accept the report such as it is, because it is the best we can get at present.

The PRESIDENT: The Chair desires to state in all fairness that this question has been before the association several times, and at the Boston meeting the committee was continued upon the ground that sufficient money had not been provided by the association to make certain experiments in this direction, but they were instructed to collect information and make a report. Doctor Moses, for the chairman, stated that they had considerable valuable information. The point now is, if you adopt this amendment or substitute you will treat all that valuable information as practically of no use. It will be in nobody's hand, except as an archive, and all the work that has been done will be lost. That is the way it presents itself to the chair. I simply state it so that you can vote intelligently. The question is on the motion to accept the report and discharge the committee.

This motion was lost.

The PRESIDENT: The substitute being lost the question now recurs on the original motion to accept the report and continue the committee.

Mr. MORRIS: I would offer as an amendment that we appoint an entirely new committee, partly of scientific gentlemen and partly of practical superintendents, and let us have a report on the facts as nearly as we can get them.

The PRESIDENT: Does Mr. Weeks accept the gentleman's suggestion?

Mr. WEEKS: No, sir. I think it would be better to leave it in the hands in which it is now placed. They have organized a movement that will ultimately bear fruit. It is true that the first returns of these inquiries will be meagre, and the burden of them will be to condemn underwriters' wire, so called. But as times go on, it seems to me, if this matter is pressed vigorously and intelligently, as those men who have been placed on this committee have the ability and power to press it, that we will get some very valuable results. It strikes me, too, that we will get from the superintendents of the companies who are engaged in actually using these insulators, the facts that we want. I appreciate the point of Mr. Mason, that it is not in the laboratory alone that these things are to be settled. We might get certain results in the laboratory that would not be borne out by the varying conditions under which these wires are used. I feel that the wise course would be to leave this in the hands of the committee now appointed.

The original motion to accept the report and continue the committee was then put and carried.

Mr. ALLAN V. GARRATT then read a paper for Mr. S. S. Leonard, of Minneapolis, on

PETROLEUM FUEL.

The use of petroleum is by no means of recent date; it was known to the ancient Greeks and Romans, being used by them for illuminating purposes, as they had no electric lights in that day. In fact, the word "petroleum" is of Latin derivation, meaning "rock oil." It has been, and is being, used for various purposes, from the sure cure of numerous diseases to the generating of steam for electric light stations. It is found in many parts of the globe, although there are but a few localities that are especially noted for its production. In our own country, New York, Pennsylvania, Ohio and West Virginia produce the greater part of the supply. Although it was known to the early settlers of these States, very little importance was attached to its value. I presume that there are none so young here but who well remember the oil craze, and the saying which was heard almost daily of "So and So" has struck "ile." Perhaps some of the members of this convention were fortunate enough to strike "ile" and possibly some were unfortunate enough to have been struck by "ile." But to return to our subject, petroleum fuel: To say that it is a new fuel would hardly be correct, for petroleum has been used as a fuel for a number of years. Experiments to determine its practicability as a fuel have been creating a great deal of attention from those interested in the matter for the last twenty years, and it is now occupying the minds of some of our ablest engineers and inventors. Quoting from a very able paper on this subject by Charles E. Ashcroft, which was published in the Boston *Journal of Commerce*, May 26, 1888, Mr. Ashcroft says that the calorific power of petroleum for the purpose of generating steam, and the evaporation of water, is several times greater than that of ordinary coal. The successful use of oil as a fuel has, however, been of very recent date, yet so rapidly has it grown in favor that to-day it is regarded as a strong competitor of coal for steam generating purposes or where heat and fire are wanted. It was with a great many knowing winks and nods of the head from the engineers and firemen, who laughed at the idea of making steam by the use of oil, that the writer attempted the use of petroleum as a fuel. Of course, it would not work, and it did not work, why? Because those who were using it did not want it to, as they were afraid some one would lose his job. We had seen enough of its workings to satisfy ourselves that it could be made a success, and the result is that to-day we are saving from 20 to 25 per cent. on the cost of the fuel, and 50 per cent. in labor, and these same men who laughed so hard on the start at our attempt to use oil would feel that this world was a poor place to live in were we to return to the use of coal, for not only their hearts but their backs would certainly be broken.

Its advantages over other fuels are many. In the first place, it is much easier handled; a steadier fire is easily maintained under your boilers, consequently the steam is kept at a more even pressure, a very important thing in the running of electric lights; there is no opening of furnace doors, allowing cold air to come in contact with the boilers, and there are no impurities in the oil such as abound in coal. When through with it, by a simple turn of the wrist your fire is put out, and your ash-pits are as clean as they were before the fire was started. In less time than it takes to tell it you can start the fire. It is only rivaled in handling by natural gas, and even then, unless we have all the modern appliances for the handling of this gas, it is far easier to manipulate.

Permit me to describe the arrangements for the handling and use of this oil put in under the supervision of the writer. The oil is received in tank cars holding from 90 to 150 barrels each (42 gals. to a bbl). From these cars it is drawn off through a valve in the bottom of the car to a storage tank or tanks, there being two of them, holding about 320 bbls. each. These are placed under ground so that the oil runs from the car into them by gravity; care should be taken not to spill the oil or stir it up more than is necessary, as the odor from it is fully equal in strength to that of new mown hay if not quite as agreeable. To prevent the stirring up of the oil, the supply pipes entering through the top of the tanks run nearly to the bottom, so that the tanks are practically filled from the bottom. In the top of each tank are manholes and a vent pipe; this latter is extended above the tanks a short distance. These tanks, which are boiler shaped, are placed end to end with a space of about eight feet between them. This gives room to get at the various pipes. They are joined together at the bottom by a pipe which also connects with the supply pipe running to the boiler room. Then in the bottom of each is a drain pipe which will admit of cleaning them out whenever necessary. There is also a gauge glass in the end of each to show how much, if any, water is in them; there is also a gauge made by a copper float, which indicates the amount of oil in each tank. In cold weather a small steam coil is inserted in the tank car around the mouth of the valve to heat the oil so that it will flow readily, for when the thermometer gets in the vicinity of 30 or 40 below, the oil is apt to be a little thick. Care should be taken not to heat the oil too much, for when hot it generates considerable gas, which is not only very odorous, but is really the cream of the fuel. I think it an advantage to have the storage tanks underground, there being less danger from them in case of fire, and during the winter the oil is less likely to chill. An open light should never be used near them, although the oil itself is really hard to ignite unless heated to a certain degree, still there is apt to be more or less gas around, which is quite explosive if brought in contact with fire. The supply pipes to the furnaces are provided with a valve where they enter each tank, also one in the fire-room. This pipe, a two and one-half inch one, is enlarged to a six inch for about four feet, and in this six-inch pipe a small steam pipe is inserted. With this, the oil is heated from 130 to 140 degrees. This lightens it so that it burns more readily, or I should say is turned into gas.

We now come to the burners, which are also fed by gravity, as the storage tanks, although underground, are still higher than the furnaces. One might suppose that owing to the recent introduction of petroleum as a fuel that some difficulty might be experienced in obtaining a burner, but their name is legion, and they are as numerous as electric light systems, and like them in another respect—each man's is the best. Our experience has been that the more simple the burner the better the result. One that thoroughly vaporizes the oil before burning it, is, we think, preferable to one that burns the oil. In the former there can possibly be no waste. In furnaces where we have been using this kind of a burner the bricks are as clean as they were the day they were put in. Steam and hot air are the other ingredients that are used in connection with the oil, and an abundant supply of the latter we have found adds very much to the efficiency of the fire.

Regarding the proper settings, circumstances will determine that to a certain extent. An excellent plan is given by the Standard Oil Company in their pamphlet, "Oil as a Fuel." This we have adopted with a few modifications which we found necessary by experience. There is no doubt that a hotter fire can be obtained from oil than from coal or wood, and when the oil is properly used the smoke nuisance is solved which has been agitating the minds of the people of some of our large cities, for there is not a particle of smoke to be seen issuing from the stack, not even when everything is running full blast.

A word as to its danger: When properly put in and handled with ordinary care, or when good common sense is used in the employment of this oil, I do not see why it should be any more apt to cause trouble than coal, although the insurance companies insist on higher rates when used. I think it more from ignorance of the subject than from there being any more danger. At the same time I am willing to admit that it could be put in and used in such a way as to greatly increase the danger of fire. So might your house be wired for electric lights, piped for gas, or a kerosene lamp hung on your gasoline stove filled in such a manner that the fire risk is much greater than with your neighbor who uses electric lights, gas, kerosene or gasoline the same as you do, but has his put in properly and handles it as it should be. As to its economy over coal I have already mentioned that there was a saving of from 20 to 25 per cent. on the cost of fuel, and from 40 to 50 per cent. in labor. From tests recently made by us, the following figures were obtained: 111.34 h. p. running six hours used 250 gallons of oil, costing $5.50, or at the rate of 70 cents per 100 h. p. per hour; 104.8 h. p. running six hours used 3,461 pounds of coal, costing $5.45, or at the rate of 86 cents per 100 h. p. per hour. Another test gave the following figures: 96.45 h. p. running 8 hours used 4,014.75 lbs. of coal, costing $6.32, or 80 cents per 100 h. p. per hour; 115.54 h. p., running 7 hours, used 233 gals. of oil, costing $5.05, or 62 cents per 100 h. p. per hour. On the above figures, oil is from 17 to 32 per cent. cheaper than coal. The highest evaporation made with oil was 14.8 lbs. of water per lb. of oil with feed water at 103, and with coal 5.38 lbs. of water per lb. of coal, feed water at 103. The coal used was a good grade of Illinois lump, costing $3.15 per ton, but which is usually worth $3.25.

In the matter of labor one man can easily attend from seven to ten 150 h. p. boilers, and then have less to do than he would were he firing one boiler with coal. After a week's run with oil your boiler flues are much cleaner than they would be from the use of bituminous coal for one night, especially Western coal. Your fire-room can be kept as clean as your dynamo room. There being no ashes you are saved the expense of handling them as well as the dirt, and the former is no small matter where some 20 tons of coal are being used every 24 hours. I might say that the above tests were made during a part of the day's run, and it is our opinion that a more favorable showing could be made with the oil where a larger number of boilers are in use. It seems to work better with a good fire than where a small fire is sufficient. With our pipe lines affording a cheap method of transportation, the future of petroleum fuel is assured; and I think there is no doubt that with true Yankee ingenuity a burner, or some method, will be brought forward by which the use of petroleum as a fuel will be greatly improved.

Mr. MORRISON: As Mr. Garratt was reading Mr. Leonard's article I asked Mr. Pope to analyze those figures. Here they are: 250 gallons of oil cost $5.50; that is seventy cents per 100 horse-power per hour. Coal costs eighty-six cents per one hundred horse-power per hour, a difference of ten cents per hundred horse-power per hour. If you take a station of five thousand or six thousand horse power and run a year that is a considerable item. This paper is a very startling one to me. I saw it yesterday, I think. It is a most startling one if the details are true. We have no reason to doubt the statements; I have none. If any gentleman has made any experiments in that direction that will throw a doubt on these statements I hope he will get up and say so. In 1865, that is twenty odd years ago, I was a telegraph operator at Parkersburg, in West Virginia. They did not get coal enough for their use. There was a man named Shipley who was engineer in the Swan House, a tavern right across from the telegraph office, and there for the first time I saw the burning of petroleum. There was plenty of it there then. Wood County had got into the habit of squirting oil out of the ground, as in Pennsylvania, and oil was very cheap. I think it is cheaper to-day than it was then. If this is true I want to know something about it, for we will be running six or seven thousand horse-power in our Baltimore station within the next six months or so. There is another item not mentioned in the paper. It costs us twenty-five cents a load, with coal, to haul the ashes away. We use a low grade of fuel. It costs a little less than three dollars a ton. It is known as screenings and soft slack coal. It has always been an open question with me whether there was very much economy in the end with it; it costs well up to three dollars before you get through with it. Now it costs you three men to handle it and out of this trash that you burn the ashes are nearly fifty per cent. of the fuel you put on the grate bars. Of course you must make allowance for these statements because I am making them off-hand. But I observe if we burn, say, fifty or sixty tons of coal of a night we generally have thirty or forty cart-loads of ashes to haul away the next day. Now that goes to show that pretty near half of the stuff comes out in the form of ashes and sand and slate from the mines. That is another item that you can charge up to the economy of this petroleum fuel. In the new station we are going to build I shall equip one battery of boilers with coal oil. Mr. Weeks, of Kansas City, is going to make large additions to his plant, and I hope he will do exactly the same thing. What do you pay for coal in your country, Mr. Weeks?

Mr. WEEKS: $2.56, non bituminous. We use about six pounds per horse-power per hour, with Ide engines.

Mr. FRANK RIDLON: I have been superintendent of a large coal tar company. From that material we got out various substances that were valuable for coloring matters. We finally came to the last portion of that which was known as dirt oil. It was used at that time for the making of glass, and was also sold latterly at a somewhat higher price for the creosoting of wood for railroad ties, spiles, etc. We at one time found it impossible to get a sale for that article, and when we had to sell it for about a dollar a barrel we found it cheaper to burn it, and we did burn it with very good satisfaction, although the apparatus for using it was very crude indeed, as to the wasting of fuel. We adopted a perforated plate and another plate that was not perforated underneath and let the oil drip down upon it.

Mr. DE CAMP: I would like to ask how long Mr. Leonard has been using oil.

The PRESIDENT: The Chair will state that he was in Minneapolis about July 10, and Mr. Leonard had then been using that oil several months. He had first made the experiment with smaller quantities of oil, but the company had got to that point where he had put these tanks in as reservoirs, and they ran in a side track alongside his station, and emptied into his reservoir tanks. It is as clean and nice a piece of business as I ever saw.

Mr. DECAMP: Mr. Leonard's paper is a very remarkable one. Some two or three years ago I paid some considerable attention to the subject of oil fuel. Several methods have been adopted in Philadelphia for the utilization of oil, but the parties who have adopted them have finally abandoned them. I was never able to learn just what their reasons were, but they used them with apparent success for some time and, from what they said, with great economy, and then they dropped it. During a residence of two years in the oil region I found that the people there who are controlling wells and who had every facility for getting cheap oil from the various refineries through the country would prefer to pay as high as $20 a ton for coal. There also would be occasionally a man who would start up with oil-burning apparatus, but that would be abandoned. Those things in connection with the inquiries in Philadelphia and the final results of their efforts there, led me to abandon the idea. I see figures are presented in that paper on the first cost of the fuel as compared with coal. There is not a very material difference, but the labor item and other expenses connected with coal which would not be required with this make the paper of very great interest to this association. I have recently got through with a test of coal. I have been using one particular coal for about four years, and we do not seem to have the benefit of the competition in the coal business. In fact we do not seem to be able to strike coal that is equal to it; and so we are confined to that particular coal. But the result of a recent test made with a new coal as compared with the coal we are now using which was a difference of 85 cents a ton. Our coal cost us in one instance 60 cents per hundred h. p. per hour and the other, 63 cents, the 63 cents being the lowest priced coal. Now we differ from Mr. Morrison; we do not use screenings. I have come to the conclusion in the last two or three years that the best coal was, taking all things into consideration, the cheapest coal to use. In the one case the cheaper coal gave about three cart loads of ashes—three and a half cart loads of ashes to every ton of coal, and in the better class of coal it was a trifle less than two. Our ashes cost us, from one station seventy-five cents a load to haul, and from another station forty cents. There is a difference in our experience in using what we think is good clean coal. We have no refuse to contend with. In the comparison between those two coals on the point of labor I do not recollect just how many men there are in the boiler house, but it would have been necessary to have put one additional man in the boiler room from the fact that the better coal would run a full fourteen hours without the fire being cleaned, and with

the other coal we would have to clean fires during the run. That would necessitate another man as a laborer in the fire room. I made up the estimate on those two coals. There is a difference of eighty-five cents a ton between them. The labor and everything else taken into consideration was equal to about $1.10 a ton. One coal costs us $2.90 put in the boiler hole, and the other cost us $2.75. Our consumption of coal is about 12,000 tons a year. The figures presented by Mr. Leonard are just about on a par with the best coal we use, so that there is no doubt of the importance of that paper if Mr. Leonard is correct in his figures.

Mr. PERRY, Providence: Last autumn about a year ago our company having decided to build a station for themselves, being simply lessees of some property and having determined on some radical changes in the arrangement of the steam plant, I thought it would be an excellent thing to put on some first-class steam engineers and ascertain not what we might do by fancy firing and jockeying, but just what we were doing in every day practice, and we selected for that purpose a gentleman very well known, who was trained under Mr. George H. Corliss, Mr. John T. Henthorn, a member of the American Society of Civil Engineers and also of the Society of Steam Engineers, and asked him to determine what we were doing. We made no changes whatever. The result was a horse-power for about sixty-two one-hundreths of a cent per hour. We used for fuel three parts of anthracite dust—not pea and dust—but simply the dust; no pea in it whatever; with one part of Pocahontas or an ordinary Flat-Top coal. The result of that was about seventeen per cent. of ash. The gentleman from Baltimore spoke of fifty per cent.. and that causes me to mention it—about sixteen or seventeen per cent. Our runs were good runs. We made forty-eight hour straight tests, running right through two days and two nights. Having some power business and also some all-day business we run our stations twenty-four hours. The result was, which confirms the statement of Mr. Morrison and also that of the gentleman from Philadelphia, about sixty-two to sixty-six one-hundredths of a cent per hour per horse-power, and in the ash, as I say, about 16 or 17 per cent. in weight. Now, another very peculiar thing was that when we just concluded our first day's run, it came on raining and continued to rain for the whole 24 hours. So far as we were able to ascertain there was not a change of a single light. The same hours were run, the same number of lights were run and everything. It took apparently an average of 20 h.p. more, the average of the twenty-four hours being, at the rate, I think, of about 142 h. p. per hour. The second day, when it rained vigorously the whole twenty-four hours, it was just 162 h. p. per hour for the twenty-four hours. We are using underwriters' wire all the way through. We have no special interruption from grounds except general leaks. The results of coal using and of oil burning seem to be about the same in the four stations—the Baltimore, the Philadelphia, the Minneapolis and the Providence stations.

Mr. MORRISON: I would rather take the gentleman's statement than my guess work. The gentleman has stated these as actual facts from tests?

Mr. PERRY: Yes. Our engines were indicated every twenty minutes.

Mr. MORRISON: Now in regard to the ash?

Mr. PERRY: As we intend to abandon the high-speed engine. I should say the high-pressure engine (we propose to run high speed the same as before, but we will use a compound engine and surface condenser), I wanted to know just what we were accomplishing with the high-speed engine, and to ascertain what benefit we would derive from adopting the other engine. We shall go into the new station in the course of three or four months. We used an Armington & Sims engine. We have not yet fully decided what engine we are going to use except that it will be a compound engine and surface condenser. We intend to arrange the station so as to get a uniform load while operating the engine.

The PRESIDENT: Did you include the cost of hauling refuse matter?

Mr. PERRY: No, sir. That is simply the net cost of the whole.

The PRESIDENT: Then you can figure twenty per cent. at least for that.

Mr. PERRY: It costs us twenty-eight cents a load to haul the ashes.

Prof. VANDER WEYDE spoke of some experiments in this city with the Clark dynamo, using a petroleum boiler. The oil cost $1 per barrel. He had calculated that at 40 cents per barrel the petroleum would be cheaper than coal delivered at $3.50 per ton.

Mr. J. M. PENDLETON: In view of the discrepancy in the results I thought it might be interesting, referring to Mr. De Camp's experience, to ask him whether he had ever heard of a petroleum fire burning the iron. I recollect many years ago that that was the complaint of many engineers, and it might be interesting to know if he ever heard of such a result being caused by the discontinuance of the use of coal as a fuel.

Prof. VANDER WEYDE: I am glad Mr. Pendleton mentioned this, because in my observation for fourteen days in a petrolum furnace I saw that it suffered greatly, and I was expecting that if it was used for a protracted time it would give out.

Mr. DECAMP: I never was able to learn anything about that. The last and most important effort made in that direction was in a shoe factory. The proprietor of that factory is a man of very large means, and rather a progressive man. He had very small facilities for coal storage, and he went to a very considerable expense, I judged, from the looks of his place, to put in the boilers and power suitable for his factory. I suppose he used 50 horse-power. I do not know whether he ever published them or not, but he made statements very freely that he was saving a great deal of money in his fuel account. I do not think he ran more than six months when he abandoned it. Whether he found his boilers were burning out or not I never heard. I sent our engineer over to West Philadelphia at one time to look at an experimental plant put up there, but there was nothing that he learned at all satisfactory to himself or me either. Petroleum has been a drug on the market for a good many years, and at points where there is a great deal of power used, and it is a mystery to me how it can be very much cheaper. It seems to me that it would have been discovered sooner, because in certain parts of this State there is great trouble in getting rid of a certain class of petroleum. This is a statement I heard made by one of the officers of the Atlantic Refining Company. He made the proposition to me when we were hard pressed for steam at one of our stations. He offered to set up a locomotive boiler and put in oil to run it with, if we would go to the expense of putting it up. I figured over that for a while and came to the conclusion I did not want to do it. I said to him, "If this is what you state it is, we will use it all over." We were then burning about 12 tons of coal a day at one of our stations where we had every facility for handling oil. He said no, that that would not do. The Atlantic Refining Company is a very large concern. He said that that product of the oil which was adapted to that sort of firing was limited—that any demand for it for fuel purposes would put the price up so high as to make it prohibitory.

Prof. VANDER WEYDE: Another illustration comes to my mind. In the city of Yonkers, at Hastings, there are gas works where petroleum was used to be converted into gas. They commenced with coal as fuel and after a while they tried petroleum, and instructed by the experience I had had before with a dynamo I told them I did not expect they would be satisfied. It turned out that way. They abandoned the use of petroleum and returned to the use of coal.

The PRESIDENT: The hour is getting very near adjournment and this is a very interesting subject. This question of burning out boilers with gas is all nonsense—with petroleum gas, because it is identically the same as natural gas when it is properly burned under boilers, and there are boilers used with natural gas burning under them lasting longer than any with coal under them. In regard to the question of economy, the only thing I know about it is the statement of Mr. Leonard. Mr. Leonard is a practical man and is running a good sized station, and I have no doubt he will stand to the figures he has given. If these two points are such as to induce this association to have a committee to see if they can get a few more statistics on this thing, all right. But so far as the present discussion is concerned it will have to close at this time.

Mr. PENDLETON: I beg to say, in reply to Mr. Duncan's remark, that the action is different in burning gas under water and burning the petroleum in the manner spoken of by the gentleman who presented the paper. In one case you have the pure gas burning and in the other case you have a mixture of steam and hot air. It is a well-known chemical fact that at white heat, usually, steam is decomposed and the action upon the iron in the vicinity would be very different.

Mr. B. E. SUNNY: The company that I am connected with in Chicago has a station just south of the city limits there. Our coal cost us about $900 a month. We were burning it by the car load. The coal was wet at the mines; it was generally wet when it was weighed, and by the time the car got to us we found it short about twenty per cent. in weight, so we got about $700 worth of coal and paid $900 for it. On investigating this question of oil burning and corresponding with a large number of gentlemen who had some experience and who had been using oil burners for a long period, we found that in most instances the same results could be had out of three barrels of oil as out of a ton of ordinary bituminous coal. Our coal was costing us about $3 a ton. We could buy oil for sixty cents a barrel, so that the equivalent of one ton of coal would be $1.80, making a saving of $1.20 on a ton of coal. The saving that we expected to get on the change from coal to oil figures at the difference between $957 a month and $540 a month, and we make a saving of $45 for the salary of a coal passer, and $12 for hauling the coal in and taking care of the ashes. We expect to make in any event a saving of thirty-five per cent., although the figures guaranteed to us by the men who are handling oil burners, and the figures which are said to be reliable by men who have experimented would indicate that there will be a saving of forty per cent. With regard to Mr. Leonard's figures as to the economy, I should say that this fact ought to be taken into consideration, that the oil cost him perhaps two and a quarter cents a gallon in Minneapolis, while it costs a cent and three-quarters in Chicago. With regard to the burning out of the boilers, I found that that largely depended on whether you could distribute your flames all around the boiler. But there are several methods whereby you can distribute your flame so equally that there will be no effect on the boiler whatever, and you can get the same result out of the use of oil as you get from the use of coal with respect to the burning of the boilers.

Mr. FRED. DELAND, Chicago: Mr. DeCamp asked how long the experiments at Minneapolis had been carried on. About nine months if I remember rightly. It was started the latter part of December or January. There is an experiment going at on New Orleans that will probably be interesting. It is the Louisiana Electric Light and Power Company. Morris J. Hart is the general manager, and he would probably give you gentlemen all the information you desire if you correspond with him. I was down there several months ago. It is stated he has the largest station in the world in capacity. He has a capacity of nearly three thousand arc lights. The horse-power, I believe, is over 1,200. He has been in the habit of purchasing his coal and having it shipped in barges down the Ohio and Mississippi rivers and wheeled in barrels 400 yards from the dock into his station. He found that by using oil he could save thirty-one per cent., and he brought that about in this way: He purchased his oil, of course, from the Standard Oil Company. He sunk two large tanks in the ground, each containing 100,000 barrels of oil. The switch passes his station. The cars are brought down to the tank, emptied there and taken back. The saving came about in the wheeling out of the ashes, the cost of hauling the coal from the barge to the fire room, the doing away with one or more firemen, and other little incidentals; but the net result at that time was the saving of thirty-one per cent. over the cost of burning coal.

Mr. COLVIN, Baltimore: I was at that station a few days ago, and the situation there is interesting. He has one battery of boilers running by petroleum and another running by coal right next to it.

On motion of Mr. Morrison, the Convention then adjourned until Thursday morning at ten o'clock.

SECOND DAY'S PROCEEDINGS, THURSDAY, AUG. 30.

The first business transacted was the reading of a communication from Mr. Somerville P. Tuck, relative to the Paris Exhibition of 1889. Also a communication from Mr. James Allison, President of the Centennial Exhibition at Cincinnati. Invitations and communications were also read from Messrs. W. H. Eckert, of the Metropolitan Telephone Company, A. S. Hibbard of the American (Long Distance) Telephone Company, and Mr. R. T. McDonald, of the Fort Wayne Jenney Electric Light Company. The last letter raised the question as to the revision of the present freight rates on arc light carbons.

A letter was also read from Prof. Elihu Thomson resigning his membership in the Committee on Insulation and Installation, which was accepted.

It was voted to print the address of welcome of Mayor Hewitt, together with that of President Duncan, in pamphlet form for general distribution.

A committee was also appointed to consider the recommendations embodied in the president's address, and to report thereon.

Mr. S. S. Wheeler then read the following paper:

OVERHEAD AND UNDERGROUND WIRES IN NEW YORK.

Mr. Chairman and Gentlemen of the Convention:

It is my purpose, in as brief and concise a manner as possible, to give you some idea of the condition of the overhead and underground wires in the City of New York, and the means which are being adopted by the public authorities to bring about a better state of affairs than the one now and for some time existing.

In 1884 the Legislature of the State of New York enacted a law to the effect that electrical companies in the City of New York and Brooklyn should place their conductors under ground. The local authorities were expected to enforce this law, and the maintenance of electrical conductors overhead in these two cities after a certain day was declared to be unlawful.

Of course, the business of telephoning, telegraphing and electric lighting could not be disposed of so summarily, and before the day appointed upon which the maintenance of wires overhead was to become unlawful fell due, the Legislature enacted in 1885 a law providing for the establishment and organization of a commission, the purpose and object of which was to provide a plan by which electrical conductors in the cities of New York and Brooklyn could be placed underground without interfering with the efficiency of the electrical service. By this law of 1885 it was provided that companies could submit to the commissions established in the twin cities plans for placing their conductors underground, and should the said plans meet the approval of the commissioners, the companies submitting them could thereupon proceed to place their conductors underground according to these approved methods.

In 1885 the question of placing electrical conductors underground was very generally disputed, and no companies submitted plans to the commission within the required time. It thereupon became the duty of the Commissioners of Electrical Subways to devise a method by which electrical conductors could be placed underground and to compel companies to carry out the work according to this method

The subject was then comparatively new, the difficulty not fairly comprehended, and the different kinds of service, as well as the ways in which the wires might be put under ground, were not even classified.

The result of the investigation made by the commission to ascertain by what method wires could best be placed underground in cities was that the commission had to listen to about four hundred and fifty plans, many of them having nothing to do with the work to be accomplished, and many of them utterly absurd.

Notwithstanding the impression that underground wires were a common thing in other cities, especially abroad, nothing had been done that would serve as experience for this city. In many places wires had been laid underground singly, in pipes, in sewers and in cables, but no such piecemeal plan could be allowed in a city having more telephones, more telegraphs, more electric lights, and less available area, than any other spot in the world, in proportion to the amount of business going on. To be of any value, under such circumstances, a plan had to be found which would permit new wires being put in from time to time, almost without limit, without disturbing the pavements of streets, and of sufficient capacity to accommodate the large number of wires, for which a sufficient space underground could scarcely be found between the various obstructions already buried.

The difficulty of the problem, and the reason why the experience of other places are of so little value to us, will be seen when it is considered that the number of wires in a given space in New York, taking the average, is very much greater than in any other centre in the world.

The places between which these wires run, instead of being in an approximately circular area, as in the case of the three other leading electrical cities, are drawn out on a long and very narrow island, thus crowding the conductors together and increasing their length between points. In addition to the difficulty of a much greater amount of wire and less area to contain it, there is the great difference in rapidity of business, which makes it necessary to be able to put up and remove wires and instruments here more speedily than in the older cities.

The ground was so filled with gas, water and steam pipes, sewer and pneumatic dispatch tubes, and their connecting boxes and man-holes, that it was impossible to find a straight course for a conduit or even a small number of ducts; and the repairs to these, which is continually going on, would make the wires specially liable to disturbance and injury. The earth is saturated with gases from the various pipes and this would collect in any open space, such as the subways would afford, destroying the insulation of the cables, suffocating the workmen, or causing explosions. In comparing wires with gas mains, it is sometimes said that the former are much more difficult to bury successfully than the latter, because the leakage does serious harm, while the leakage from the gas pipes is of no consequence. It is true that the loss from escaping gas does not cripple the gas companies' business, at their present prices, but the gas fills the earth, gets into the electrical conduits, and there makes a very bad combination, for which electricity has to stand the whole blame. Indeed, if it were not for the gas the underground wire problem would be easier, and very much more agreeable. On the other hand, when the electric current wanders off and melts the iron of the gas pipe, electricity again has to stand the blame, and thus there is not a fair distribution of the responsibility.

In order to treat the subject thoroughly, the Board of Electrical Subways, of the City of New York, investigated all the different systems in use in other cities; in connection with the many plans which were submitted for approval to be used in New York.

It was found that in Paris they are fortunate in having extraordinarily large sewers, through which in the streets where the sewer run all of the wires are laid together with the gas and water pipes. These sewers consist of a large arched passage with a flat floor, through the centre of which runs a deep trench or canal for the sewage. The flat pavement on either side of this forms a broad walk, over which the pipes and wires are suspended from the arched roof. A rail is laid on either side of the canal, and on the track so formed a car can travel carrying a drag which is used in cleaning the canal or sewer proper. In the streets which do not have these sewers the wires are strung upon the housetops.

The only other place which at that time furnished experience at all applicable to the problem here was London. But here there were and are now practically no arc lights at all, and therefore no circuits; there are extremely few incandescents, with no out-door circuits; the telephone is not used very extensively, and the wires of the telegraph are placed underground by the government. The plan employed is what might be called the handhole drawing-in system, and consists of five inch cast-iron pipes laid under the sidewalks and accessible through handholes or "flush boxes." These pipes are said (I do not know how correctly) to be loosely jointed for the purpose of admitting water to preserve the cables, which are of gutta percha, the same as is used for submarine cables, and which deterioriate very rapidly when exposed to the air. In other words, they have learned by their experience with ocean cables how to make insulation which will stand the water, so they try to convert the subway problem into the same kind of work. Conduits have been laid at a later date in other places.

In Brooklyn there are about ten miles of Dorsett conduit, and about four and a half miles of a conduit consisting of a wooden box made of creosoted boards loosely put together, with narrower ones slid into grooves on the inside to form partitions. This duct, being loose and unstable, simply affords a means of keeping cables from touching each other and keeping them in place; and as creosote will dissolve rubber it is not a good place in which to put a rubber cable.

Another plan which has seen some slight use in Philadelphia is the Johnstone system. This consists of a broad, flat, cast iron duct, made in sections, about six feet long, and divided horizontally into an upper and a lower half or shell, so that a section can be removed and another substituted without cutting the wires already drawn into place. The duct is divided into a number of smaller ducts, for classifying the wires, by partitions consisting of long slabs of cast iron, which are slid into place in grooves cast in the inside of the outer shell. The feature of this system is the facility which it affords of introducing an outlet from the duct exactly opposite any lamp-post or desired part of a building, by taking off the upper or lower half of a single section and putting in its place a new half section with a hole in it at the desired point, to which a branching elbow can be bolted.

This construction has been authorized for a distributing system in New York on Broadway from 14th to 34th streets, for arc lighting, etc. The work is now being prepared, and the system is, therefore, of some interest. (See cut, page 123.)

There goes with this style of conduit a manhole formed of a bottom, a top, and variable number of rings or sleeves placed upon the other so as to build up the heighth of the manhole and permit of the ducts being run out at any depth to escape pipe obstructions, etc. One of these sleeves is split up into a number of panels bolted together, any one of which can be taken off to allow the ducts to be run out on either side at any angle.

All of the other plans by which wires have been put underground, except the Dorsett and other manhole drawing in systems used in this city, which will be described later, consist of nothing but the wire with covering buried in a trench, and are of no value beyond the taking care of their own particular wire.

Prominent among such plans may be mentioned the Edison tubes. This system, which has been extremely successful for its one kind of service, consists of heavy copper rods wound with rope, and laid in wrought iron pipes filled with an insulating compound composed of Trinidad asphaltum, rosin, paraffin and linseed oil. This compound is run into the pipe when heated to about 300 degrees Fahrenheit, under considerable pressure, while an exhaust is applied to the other end for the purpose of drawing out all air bubbles. The end of the tubes are then plugged with wood soaked in paraffin, leaving the coppers projecting.

The chief peculiarity of this system of conductors, and the feature of which is, perhaps, most familiar to all, is the means of connecting up these lengths of tubing and conductors. The rods are connected by short pieces of copper cable terminating in suitable copper sleeves, which are soldered to the ends of the rods when in position and the bow-shaped expansion joint so formed is covered with hot compound poured into a small cast iron coupling box which is bolted on to the junction. The lines terminate at the street crossing in large cast-iron boxes, like manholes, where the rods are joined by heavy copper cables to suitable connecting device near the top.

This plan is too expensive except for very heavy conductors, but serves admirably the requirements of incandescent lighting. In the early days of the system the thin pipes were greatly damaged by picks in digging around them and by outside disturbances. A slight blow from a pick would puncture the pipe, letting in a little water, which was liable in time to form an arc between the conductors, which would in turn burn the compound, converting it into a conductor, and forming a short circuit. The greatest difficulty with these tubes was found to be that the insulator would be converted into carbon by the charring action of leaks at the slightest start.

Tubes of the same style, but containing a large cable of small wires, have been in successful use in carrying telephone wires out from the Twenty-first street Exchange in New York.

Another method somewhat similar is the Brooks system, which consists of wires covered with cotton and drawn through large iron pipes, which are afterwards filled with a heavy rosin oil, so as to prevent the water from entering. This oil is a good insulator.

The remaining plans are of the lower grade of mechanical construction, and consist of wires and cables of various kinds laid in troughs and covered with some protecting substance, usually tar or asphaltum.

Among these may be mentioned the few telephone and telegraph wires in Boston made into a cable and laid in a trough and covered with bitumen. A few telephone wires in New York and electric light wires in Pittsburgh are laid in the same way.

There are also innumerable places where cables of various kinds are laid directly in the earth, sometimes with a board covering to protect them from men with shovels. But none of these are of special interest to us, because obviously we cannot use them.

The results of the investigations of the commission were summed up in their second report, dated June 30, 1886, as follows:

"The principal systems of electrical subways may be divided, first, as to their material composition, and second, as to their mechanical construction, and the manner in which the wires are placed in them.

As to material composition, subways are:

1st. Of insulating material, such as wood, glass, concrete, etc.

2d. Of conducting material, such as iron.

As to mechanical construction, subways are generally speaking:

1st. Tunnel systems.

2d. "Drawing-in" systems.

3d. Solid systems.

4th. "Dropping-in" systems.

5th. Combined systems.

Tunnel systems, or those where space is provided underground sufficient to allow the passage to and fro of men who place the wires within the subway, could be recommended, were unlimited time and money at the disposal of the commission; but the expense of such a system and the crying need of immediate action preclude the adoption of such a plan. If ever underground railroads become a feature of our city transportation then, perhaps, the tunnel can be used for some of the future trunk line cables.

In Paris, where the foundations of the city are honeycombed in all directions by large sewers, such a plan is practicable and admirable, but not to be thought of in New York.

Drawing-in systems, or those where man-holes are provided in the streets, connected by tubes or pipes, through which the wires can be drawn, are next in prominence and convenience to tunnel systems.

In Chicago there were seen in successful operation nearly twenty miles of conduits of the "drawing-in and out" pattern of various materials, containing all kinds of wires, as follows:

Eight miles of the Dorsett system of concrete conduit divided into ducts, and containing in the separate ducts wires of the city telephone, telegraph and fire service, electric light wires and wires of different telegraph companies.

Four miles of the Johnstone system of iron conduit divided by metal shelves, and carrying the wires of the Postal Telegraph Company.

One mile of 3-in. iron pipes, four in number, carrying the wires of the Western Union Telegraph Company.

Three miles of iron pipes, carrying the wires of the Bankers and Merchants' Telegraph Company.

In Philadelphia a comprehensive "drawing-in" system of iron was seen, containing electric light and telephone and telegraph wires.

In Boston some two miles of such "drawing-in" iron systems are in operation.

In London 9,000 miles of wire are underground, bunched into cables and drawn into 3-inch iron pipes.

Solid systems, or those where wires are permanently embedded in insulating material and incapable of being reached except by tearing up the streets and the insulation, have been found to work with more or less success. The Commissioners saw several miles of this conduit in successful operation in Chicago by the Telephone Company there, where wires were buried in an asphalt or coal tar cement, laid in a wooden trough.

Several miles of similar conduit are in use in Washington for electric lighting, and there are other instances of the successful operation of this description of conduit.

In this city of New York there are several systems in use underground, each more or less satisfactory to those employing it.

A prominent example is the Brooks system used by the Metropolitan Telephone and Telegraph Company. It consists of an iron tube in which cotton-wrapped wires are drawn, and the tube filled with oil, the oil acting as an insulating medium. It is kept at a desired pressure—the tubes constantly full by means of a stand-pipe. They use a 2½ in. iron pipe, and the system is cheap, costing less than $11 per mile of wire, because into such a pipe they can draw 300 telephone wires. Wires for telephone purposes, and those used in the American District and other call boxes, are of a very light intensity, and do not need as heavy insulation as do all other kinds. This system is claimed to give perfect satisfaction for telephone conductors.

The Western Union Telegraph Company has many wires already down in this city, laid in 3-inch iron pipes, into which they draw cables manufactured from okonite or kerite insulation. These pipes are lead-jointed, are laid in Broadway, and have man-holes occasionally for taking out the wire.

To sum up as to the form of subway, and the manner in which the wires are to be placed in it:

We are convinced that from the standpoint of an electrician simply it may be said, that almost any plan or system can be made to work, from a single lead covered wire laid directly in the earth to a great tunnel upon whose walls the insulated conductors can be hung. Within certain broad limits any system is electrically practicable; retardation and induction can be overcome. It is only when we face in this city the mechanical engineering and chemical questions of interference with water-pipes, gas-pipes and sewer-pipes, of obstructions from vaults, or danger from steam-pipes, of the action of sewer and illuminating gas, that the necessity for careful discrimination presents itself.

In the future, when the uses of electricity become more general, and its nature better known, it may be that the city of New York will absolutely require a grand electrical underground highway, where space can be provided for the conducting and distributing of sufficient power to run all the engines and work all the machinery within the city limits. It may be and probably will be, that before such space is needed, much more will be known of the qualities of different forms of electrical conductors, and of the best method of carrying them underground, and that the matter of electrical subways will be no longer experimental, but practically demonstrated in every detail.

When such a time comes the commission or other authority will determine what is required to meet the necessities of the occasion.

The responsibilities of the present commission begin and end with providing for the requirements of their own day, and for such of the exigencies of the future as they can reasonably anticipate.

Leaving out of consideration all tunnel systems as too expensive, we must also discard any system which calls for the simple laying of insulated cables in the earth. They would not stand the chemical action of the gases and acids; the streets would be continually torn up for new connections and repairs. We are thus shut up to the question of electric subways or conduits, in which the wires or cables, insulated or otherwise, must be placed, and which once laid down should meet all the demands of the present and near future.

Of conduits it may be safely predicated that, so far as the experience of this and other cities is a test, some form or other of a "drawing-in" system is most convenient. The life of the best cable is by no means satisfactorily decided, and, of any particular cable, to predict how long it would last would be purely speculative. Of wires not contained in cables it may be said that they are equally more uncertain in their length of life and usefulness. At all events for purposes of distribution it is desirable that the wires should be easily approached at frequent intervals, and the commission cannot countenance any plan that looks to the disturbance of pavements more than is absolutely necessary.

It may be that through lines of wire could be better protected laid in permanent beds of insulating material; but a "drawing-in" conduit system allows space to be provided for new wires without the frequent tearing up of pavements.

The commission can, therefore, give their approval to a "drawing-in" system with frequent manholes, as the general form of subway best adapted to meet the requirements of the electrical service of the present.

Up to this time it was the general impression, which had not been contradicted by experience, because there was none, that the conduits must be built of a non-conducting substance, and not of metal, because the latter would be liable to chafe through the insulation on the wire and cause a ground, and because the companies using the more delicate currents—particularly the telephone company, declared positively that the presence of the large mass of surrounding metal would interfere by induction with the working of their wires.

The best known plan at this time for building ducts of insulating material, and without the use of metallic tubes, was the Dorset system, which had been laid to some extent in Chicago.

This consists of a bundle of parallel tubular ducts about two and a half inches in diameter, built of blocks formed of a combination of coal tar, pitch and fine gravel, cast with tubular openings running through them from end to end. These blocks were placed together, end to end, with the holes in line so as to form continuous tubes or passages, and were cemented together by pouring a mastic, softer than was used in making the blocks, into the cracks between them. The blocks were made to adhere to this by warming their ends with hot irons and allowing them to cool after this mastic is poured in. To prevent the melted mastic from closing the ends of the passages, tubular pieces of metal or paper were inserted in the ducts at the ends of the blocks, making a sort of internal sleeve coupling. The conduits so formed terminate in brick manholes at the street crossings.

The objections to this material, as it was afterwards found, are that it is brittle, porous, requires care in laying and, having no elasticity, cracks with changes of temperature, so that it is not likely to be made water-tight with average workmanship.

But a conduit was accordingly laid in New York upon this plan on Sixth avenue from Twenty third to Fifty-eighth streets, a distance of 1.6 miles. And the objections were then found, as far as arc circuits were concerned, that its numerous joints were liable to open, and it might leak as mentioned above.

The next plan proposed for New York was to use a similar mixture without requiring it to be made so hard, with the object of preventing its cracking, and to preserve the openings or ducts by casting this bituminous mastic or mixture of bitumen and sand around long pasteboard tubes. But no tubes could be found which would not absorb moisture, and the heat of the mastic caused the ones tried to swell up and disintegrate. The manufacturers of indurated fibre wares were confident that satisfactory tubes could be produced, but it required special machinery and a long time for experiments. Tin and sheet iron linings were then suggested, but objected to, on account of the difficulty of making good joints. Zinc, however, was considered unobjectionable, and an experimental tube of the Averil system, consisting of soldered zinc tubes in bituminous mastic was laid in the yard of one of the manufacturers, but it was found that the heat of the mastic melted the solder of the tubes. This difficulty was met by substituting a lap or fold over seam, and then it was found that the heat of the mastic also affected the nature of the zinc, impaired its durability. On account of the certainty of the zinc tubing rusting and finally crumbling away it was next thought best to insure the permanence of the bore of the ducts by substituting for the soft mastic some substance which would set, after being poured in, and become hard and durable. For this purpose a hydraulic cement concrete filling was substituted for the mastic. And then a line was laid in Fifty-eighth street. In laying, the thin zinc tubing was found very frail, liable to be dented in handling and therefore undesirable. But the idea of the concrete was that it would maintain a hard, solid, smooth bore even after the thin sheet metal lining had rusted out.

After a thorough investigation and discussion of all the different materials, and the advantages and disadvantages of each, it was finally concluded that a conduit or subway for electrical conductors under ground is merely a mechanical protection for the wires to be placed therein and should afford the very best protection possible to be procured, while the electrical protection or insulation may be safely left to the manufacturers of cables and wires to be placed in subways.

It was decided that the use of metallic tubes would not seriously interfere, by induction, with the working of the wires, and were to be preferred because the continuous conducting shield so formed will carry off any escaping current and prevent damage to other cables. Accordingly conduits of iron gas pipe embedded in concrete were put down, and these seem to be about the best kind so far constructed. They are best, first, because there are plenty of workmen who understand gas pipe fitting and laying concrete, and because they are durable and entirely non-combustible. The purpose of the cement is to prevent the iron from rusting, which it does very effectually. If in time the pipes are destroyed by rusting from the inside, the solid hydraulic cement concrete will remain, furnishing a permanent duct with a hard, smooth bore.

The manholes used in connection with these various kinds of ducts have nearly all been built of brick laid in hydraulic cement, and capped with an iron casting to form a seat for the water-tight lid. The lids are usually bolted down upon a rubber gasket, but unlike the Edison manholes, instead of being held by a single thrusting screw which passes through a crossbar, presses down upon the centre of the cover. Some of the lids have been made funnel shaped so as to cause water to drain away from the edge and collect in the centre. By this means the liability to leakage at the gasket is diminished, because there is less chance of water standing over the joint. The facility of opening the manholes afforded by this method of fastening the lid with a single screw is of great value in reducing the labor and time required to open and close a line of conduit when laying a wire, and is a material advance in the solution of the problem.

In regard to moisture in the conduits. In the iron tube plan, which is the best, there is, of course, no leakage, because the tubes themselves are water-tight, could even be made air-tight, and because they are covered with cement, which is in itself water-tight. The manholes are made of water-tight materials and there should be no leakage under the lid. Lookers-on find that a great many of the manholes have a great deal of water standing in them; this is simply because the lids are not fastened down, but simply laid in place by the builders, often without any gasket, and the manholes fill with rain and stay full until cleaned out for use. When cleaned and closed properly they appear not to receive any water by leakage. To satisfy myself of this I had an ordinary brick manhole which had been thoroughly cleaned and dried by letting the sun shine in, on a bright day, marked on the inside with lime all the way round under the cover and then closed. This marking was to show whether any water came through the joint of the cover, in which case it would have run down over the lime mark and discolored it, or whether it soaked in through the bottom or sides. But after a rainfall sufficiently heavy to test the leakage, the hole was opened and found perfectly dry and the lime undisturbed. This proved that there was neither leakage through the brickwork or under the cover.

There is, however, another source of moisture which is hard to overcome, the condensation of vapor from the air which the manhole and ducts contain. Every time a hole is opened it refills itself with warm air, containing more moisture than it can keep when cooled down to the temperature of the masonry; consequently as soon as the lid is screwed down this fresh air deposits a dew on the inside of the manhole. As it is impossible to open and dry out a manhole without putting in new air, which will condense in turn, no amount of cleaning will overcome this difficulty. The presence of moisture tends to corrode exposed wires, and therefore the question of whether it is better to protect the splices and make the insulation of the wires so that they will not be injured by this moisture, or to dry out the entire system of conduits by a system of ventilation, is unsettled. But this question, fortunately, is one of minor importance.

The question of distribution of electrical currents from the main subways constructed in the manner I have described has been largely left by the authorities in the city of New York to the preference of the electrical companies.

Two systems of distribution are at present actually in use in New York by the telephone company. These are known as the house-top system of distribution, an example of which may be seen at Sixth avenue and Fifty-first street, and the hand-hole system of distribution, which may be seen at Broadway and Exchange place.

In addition to these systems, there are five modes of distribution which can be readily applied to the subways as constructed in New York, and which will be allowed in cases where they are severally most expedient, the lamp-post system of distribution, the house-front system, the house-vault system, now in use in Chicago, the back-yard system and the manhole system. In the heart of Chicago the distribution question is peculiarly easy of solution, because the side-walks were left hollow by raising the street levels after the great fire, and the wires are run through these spaces to the houses.

Having decided the question of the kind of conduit to use, the commission proceeded to have subways constructed according to these plans. It was decided best, as a matter of expediency and to prevent accident, that electric light subways should be distinct from those intended for telephone and telegraph service, and it has, therefore, been the practice of the authorities in New York to build subways for one class of conductors upon one side of the street, and reserve the other side for those of other service.

The telephone people were the first to realize that underground wires were sure to be ultimately a success. Their business had grown enormously, they had reached about the capacity of their pole lines, and it was not easy to get the use of additional streets, because the streets were crowded with wires, both their own and those of other companies. It was found that the growth of the telephone business was practically put an end to by the fact that no more room could be found in which to string wires. House-owners were charging a rental of one dollar per wire per year, which, in some cases, amounted to a very large rental in the case of a building, and the telephone people had reached the point of refusing subscribers. They came forward, and were the first to declare for underground wires.

After some resistance, the telegraph and electric light companies have come to the conclusion that it is as well for them to comply with the demands of the public and place the bulk of their conductors underground. And, as a matter of fact, in the city of New York to-day there is but one single company out of the large number doing business here which refuses absolutely to comply with the provisions of the subway acts, and nine-tenths of the opposition and outcry has been caused by this company.

At the present time the total construction of single duct in the city of New York amounts to 420 miles. In these subways there are already in operation some 4,000 miles of telephone and telegraph wires, and some hundreds of miles of incandescent electric light conductors. Cables for arc lighting are to be drawn in on Broadway from Fourteenth to Thirty-fourth streets by the Brush Electric Illuminating Company within the present week. A letter from the electrician of the Metropolitan Telephone and Telegraph Company, bearing date Aug. 25, as estimating the exact length of cables of various kinds now underground, is as follows:

NEW YORK, Aug. 25, 1888.

S. S. Wheeler, Esq., Electrician of the Board of Electrical Control.

DEAR SIR: I have hastily collected the following information relating to the underground mileage of wire.

The number of miles of single wire conductors in New York city of the various kinds is as follows:

Brooks system, laid May 28, 1885..... 200 miles.

Patterson cable, laid March 18, 1885	226 miles.
Edison system, laid June 20, 1885	194 "
Patterson cable, laid in 1886-87	805 "
Patterson cable, twisted in pairs, number of miles counting both wires in 1888	2,272 "

We have in course of construction some 12,000 miles of conductors which will be laid in September and October.

Total number of miles already laid in New York	3,697 "
The number of miles of underground wire in Brooklyn	2,100 "
The number of miles of underground wire in Pairs	4,100 "
" " " " " " Chicago	200 "

As per report of telephone convention held Sept. 26, 1887:

The number of miles of underground wire in Boston	400 "
" " " " " " Pittsburgh is about	1,000 "

I find that there is a very small amount of underground wires used in London for telephone purposes, there being some short lengths used entering exchanges, which is not worth while considering. Repectively,

(Signed) J. A. SEELY, Electrician.

It will be seen from this that there are already underground in the city of New York more electrical conductors than in any other city in the world, while the capacity of the construction already finished in this city may be estimated fairly at something over 30,000 miles of conductors.

There are through lines completed from the Battery to the Park, on the two principal thoroughfares of this city, Broadway and Sixth avenue, and a gradual conversion of overhead systems to underground ones in the busy parts of the city may be confidently expected.

The Board of Electrical Control is not unmindful, however, of the magnitude of the labor and expense required in converting the present arrangements into underground systems, and does not contemplate either the hampering of the business of electrical companies by forcing unreasonable numbers of wires underground, or by attempting to compel the use of subways faster than is consistent with the efficient use of the different electric service by the public. If the great mass of overhead conductors are removed, and the remainder of the service brought to a condition which will insure the safety of the public and, at the same time, the welfare of the companies themselves, it will be the result desired by the people of the city, and which the Board of Electrical Control is endeavoring to attain.

As to this matter of regulating the overhead service in the city, I may say that an investigation of all the wires overhead, instituted since I have been connected with the work of the authorities in charge of electrical matters here, by the inspectors appointed after a rigid examination, and found competent for the purpose, has shown that a great deal of very bad and unnecessarily dangerous work has been done in New York, and that a reprehensible and inexcusable condition of overhead wires is the principal, if not the only, cause of the clamor for underground service.

In addition to this, an enormous quantity of wire and a large number of poles, not in use at all, exist, amounting, as has been variously estimated, to from a half to two-thirds of all the wire and poles in the city.

As I have said, a system of inspection and reports has been organized, and within a few months there have been found and reported to the owners 2,000 dead wires and other objectionable things described in the inclosed schedule, which explains itself. A notice is sent out in every case; at the end of a week the work is again inspected, and if nothing has been done the owner is again notified, and if the wires, poles, etc., are not necessary, a notice is also sent to the Bureau of Encumbrances of the Department of Public Works to remove them.

All arc lamps that are so low as to be within the road of pedestrians with an umbrella are reported as too low. Circuits which have especially defective insulation or joints are reported as dangerous. A few cases of bad indoor work have been reported as violating the rules of the Board of Fire Underwriters, and so on. The number of complaints sent to the various companies, as well as the proportion of them that receive attention by each company, are shown in the detailed schedule, which indicates the position taken toward the work of inspection by the several companies, and I may say that the single opposition company, of which I have already spoken, is the only one which disregards the notification of flagrant bad work, for which there is no excuse, and which every one else admits should be inspected on behalf of the public, and corrected immediately.

One has no idea of the aerial freebooting that is and always has been going on with overhead wires, until they spend some time seeing what there is overhead. The condition of wires in this city is simply outrageous. Every other kind of business, such as those which involve obstructing the sidewalks, has fallen under the supervision of some branch of the government, and cleanliness and order have been insisted upon, but heretofore there had never been any supervision of out of door wiring, and its condition corresponds to that of a city without police supervision.

The companies owning wires will not permit each other to make common use of the poles, but will chop off wires owned by others without notice. The telephone people object to the electric light wires on account of the induction. Where there is a line of light wires on their side of the street passing close to their poles they will not allow them to be made fast. The result of the necessity thus made for extra poles is sometimes four lines of poles on one side of the street, hence most of the wires swing close to or against the other poles to which they are not attached, and linemen in climbing them have to crawl through all the other wires which are not fastened to cross-arms.

Among the causes of dangerous wires and unnecessary obstructions found by the inspectors are full lines of large poles, extending over miles of streets, filled with wires which are "open" and out of use, but left standing to save the expense of removal; long lines of poles left standing to preserve right of way, arc light day circuits within reach and with the insulation dropping off, and bunches of dead wires hanging from housetops, etc.

All of the work of inspection done by this department is such as is necessary for improving the condition of overhead electrical work and removing fixtures, etc., that are absolutely dangerous and objectionable.

For the purpose of the various legal proceedings which are being carried on to compel the most objectionable arc light company to make a start in placing their wires underground, the other principal companies having preceeded voluntarily; the pole line on Twenty-fifth street from Broadway to Fifth avenue was chosen for special complaint. The subways on this route, which were specially provided for these lines, have been finished for some time, and are dry and in good order.

This line of overhead wires is in bad order, one of its stretches having no less than thirteen splices, and it is made still more liable to do damage by the presence of numerous dead wires, which not being required for use, are practically stored upon the cross-arms.

In conclusion, we may sum up the situation about as follows: The telegraph and telephone problem is practically solved. It is found necessary to resort to subways in order to get sufficient space for wires, and wires for this use are being drawn into the tubes as fast as the labor can be performed. There are about 4,000 miles of telephone and telegraph wire already underground, and 12,000 miles of cables about to be laid in the fall. It is estimated that the saving in cost of maintenance will be about $100,000 per year, owing to the permanence of the style of work which is possible underground.

The laying of electric light wires has not been so fully developed, and naturally none of the companies care to bear the expense of the first experiment. But after the initiative has been taken, the difficulties will be overcome as they arise, as in the development of all other enterprises, and the undergrounding will become a settled and accepted fact.

Meanwhile the lawless running of overhead wires is being stopped. All wires in a street must be run on a single line of poles. Here and elsewhere the dead wires and poles must not be stored in the streets, and all construction must be made under the supervision and control of some official in precisely the same way that other works which affect the public are carried on.

After a short discussion on the cost of conduits by Messrs. Lynch, Leslie and Wheeler, further discussion was postponed until the afternoon session.

Mr. E. G. Acheson then read the following paper:

DISRUPTIVE DISCHARGES AND THEIR RELATIONS TO UNDERGROUND CABLES.

From among the numerous problems that are earnestly calling for solution, before perfection can be claimed in underground systems of electrical distribution for arc lighting, I selected as the one presenting probably the greatest importance, and, consequently, the one most desirable to solve, *the determination of the cause and cure of the frequent puncturing of the insulation, especially at the terminals, of lead encased conductors, when carrying high potential currents.*

In a communication to the electrical press * under the title, "The Influence of the Condenser on Disruptive Discharges," a detailed description of a series of experiments on the discharge between points in air was given, they having been made with varying E. M. F.'s and condenser capacities.

These experiments resulted in the formulation of the general law expressed in the equation:

$$\frac{(E.\ M.\ F.)^2 \times (\text{charge in coulombs})}{a} = d;$$

or

$$\frac{(E.\ M.\ F.)^2 \times (\text{capacity})}{a} = d,$$

where a is a constant for the dielectric, and d is the spark length, the charge being expressed in coulombs and the capacity in microfarads. In the same article the value of a was taken as 135 and d was expressed in inches.

While these experiments may serve as a basis or foundation to build upon, much more must be known before they will meet the requirements of the engineer operating with high potential currents, and with the object in view of obtaining at least a small portion of this required information, my experiments were extended into the more practical part of the subject, and furnished the results I have embodied in this paper.

The most probable condition of a discharge in a cable would be between the cylindrical conductor and a point or projection on the lead covering; hence the first point to determine was the striking distance between such a cylindrical body and a projection or point.

Experiments were made with a point and the side of a wire, two sizes of the latter being used, a No. 8 and a No. 16 B. & S. wire gauge. There was no difference between the results obtained with the two sizes. The length of the spark was found to be about 55 per cent. when compared with that produced between points with the same E. M. F. and capacity.

This difference gives a new value for the constant a, which is found to be 263.

The equation for the spark length between a point and a cylinder will therefore be,

$$\frac{(E.\ M.\ F.)^2 \times (\text{capacity})}{263} = d \text{ (inches)}.$$

The following approximate values of a have been determined, for the conditions and dielectric specified, d being expressed in inches.

Dielectric.	*Spark between.*	*a.*
Air	Points	135
Air	Points and wire	263
Paraffine and cotton	Point and wire	5,822
Ozite and cotton	Point and wire	7,759

The conditions governing the possible disruptive discharge, through the insulation of the covered, grounded cable, are so numerous that it would be quite impossible to exhaustively consider them, even if the necessary data were at hand, within the limits of this paper. It will, therefore, be necessary to confine the subject to the more important conditions, and the exposition of the law by means of a case that might be found in practical work.

In Fig. 1 is illustrated a portion of an arc-light circuit, consisting of the dynamo D, and 30 lamps L, connected in series by a lead-covered underground cable. For the purpose of illustration and calculation it is assumed that the lamps are separated a uniform distance of 300 feet; the size of the conductor, a No. 4 B. & S. wire gauge, insulated with one-tenth of an inch of cotton and paraffine; the capacity per mile is 0.704 microfarad, and the E. M. F. at the brushes of the dynamo 1,500 volts. Also, as an assistance in calculation, it is supposed that the drop in the E. M. F. occurs in the lamps only.

The capacity of each one of the 31 sections of cable separating the lamps and dynamo, and which are numbered in regular order from 1 to 31, will be 0.04 microfarad, and the capacity of each division, from conductor to conductor across the circuit, as between sections 2-30, will be,

$$\frac{.04 \times .04}{.04 + .04} = .02 \text{ microfarad},$$

or, in this case, one-half that of one side.

With these conditions each division, composed of the paired sections, as 1-31, 2-30, 3-29, and so on, will have a potential tending to break through the insulation of the lead and thence across the intervening medium in the direction of the broken lines, of a value of 1,500 volts at 1-31, and decreasing by 100 volts for each succeeding division.

These various potentials will, provided the insulation is perfect and the leads well grounded, induce a static charge between the conductor and the lead of each section, of a value measured by the potential across the division, and the specific inductive capacity and thickness of the insulating material.

In the case under consideration, the thickness of the insulation and the specific inductive capacity are such as to induce a condenser capacity of .02 microfarad, and with an E. M. F. of 1,400 volts, as would exist between 2-30, the charge would be $1,400 \times .02$ (m. f.) = .000028 coulomb; and if the conductors forming the two sides of this division should, while in this charged state, be insulated from each other, as might be done by breaking the electrical continuity at both ends of either one of the sides, the energy stored within it would be able to produce a disruptive charge through air, from the conductors to a point, or *vice versa*, equal to

$$\frac{(1400)^2 \times .000028}{263} = .2087 \text{ inch}.$$

This is almost $2\frac{1}{10}$ times the thickness of the insulation; but the thickness of cotton and paraffine, composing the insulation of the cable that this energy would pierce, would be:

$$\frac{(1400)^2 \times .000028}{5822} = .0094 \text{ inch},$$

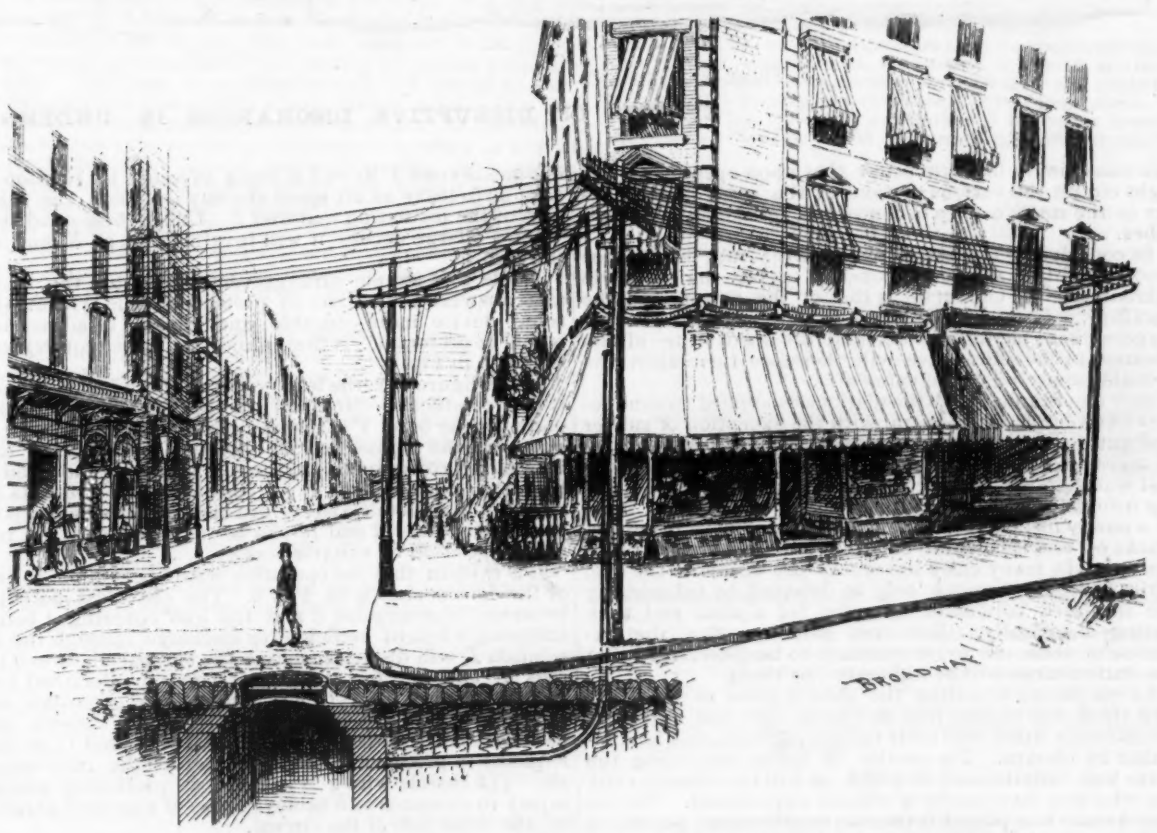
or less than one-tenth of the thickness of the insulation.

Two questions now present themselves. First, are the sides of division 2-30, or any one of the others, liable to become insulated from each other, or attain a condition favorable for a discharge; for will there not always be a path open for discharge around the circuit, either by way of the lamps or the dynamo? The second question may be stated thus: Is it probable, with the conditions of the case above taken, that the insulation will ever be pierced, seeing that the discharge through the insulating medium, cannot be greater than .0094 inch, whereas the thickness of the insulation is 0.1 inch?

It is evident that from accidental causes, such as the breaking of the circuit at two points, it is possible to have the two sides of the division insulated from each other; but such accidents are not liable to occur, especially when it is remembered that the breaks would have to be made simultaneously. To make the probability of this action occurring worthy of consideration, other means of producing it must be looked for and found.

On a circuit using coils shunted around the arc, the electrical continuity is established at each end of the two sides of the division, by one of these coils and the arc.

From the experiments of various experimenters, prominent among whom may be mentioned Prof. Hughes and Dr. Oliver J. Lodge, it is concluded that the self-induction in these coils would be of such a value as to offer an almost insurmountable barrier to the flow of the charge through them, and this being the case the discharge, if it occurs at all, must be through either the arc or the insulation of the cable. To determine whether the charge would pass off through the arc, the apparatus shown in Fig. 2



METHOD OF LOCAL DISTRIBUTION FROM MANHOLE.

* See THE ELECTRICAL WORLD, July 7, 1888.

was used. Twenty incandescent lamps *L L*, of 100 volts each, were connected in series to the lines *M N*; in the line *N* was placed the switch *S* and the contact points 1 and 2, the former being mounted in the revolving post *P*, thereby permitting of the points being opened. The condenser *K* was connected across the circuit from the line *M* at a point 3 between the switch and the contact points on the line *N*; around the condenser were placed the points 4 and 5, with suitable means of regulating the distance between them. *M* and *N* were connected to the sides of a transformer supplying an E. M. F. of 2,067 volts. The points 1 and 2 being in contact, no amount of rupturing of the circuit at *S* and adjusting of the space separating 4 and 5 would cause a discharge to occur between them; but upon opening the points 1 and 2, and thus establishing an arc in the circuit, the opening of the switch *S* would cause a heavy discharge between 4 and 5.

From this experiment and Dr. Lodge's results with circuits containing self induction, the conclusion must be drawn that conditions favorable to a disruptive discharge has the even greater fault of losing its insulating qualities and running off the conductor when heated, as might occur by an accidental over-loading of a circuit, and when it is confined, as in a lead covering, it permits the conductor to become decentralized and eventually come in contact with the lead casing. Between the two insulators, with the faults specified, inseparably associated with them, there would, for high potential currents, be little or no choice, but fortunately means have been devised whereby the existence of the cracks or crevices in the fibrous insulating envelopes when properly protected from water by a metallic casing is immaterial, as they are sheared of the power of diverting the discharge into the paths opened by them. These ends are accomplished by the simple expedient of causing the discharge to occur at such a place and in such a manner as not to pass through the insulating envelope.

This may be done in a great variety of ways, but the most simple one that has suggested itself to me is shown in Fig. 3, where *A* is the lead cover, *I* the insulation, *C* the conductor, and *P* a wire connected to *A* and extending out beyond *I*, its end *K* being adjusted in relation to *C* so as to leave an air space slightly less than the thickness of the insulating material *I*. Under these conditions when a charge occurs it will invariably be at *K* and not through *I*.

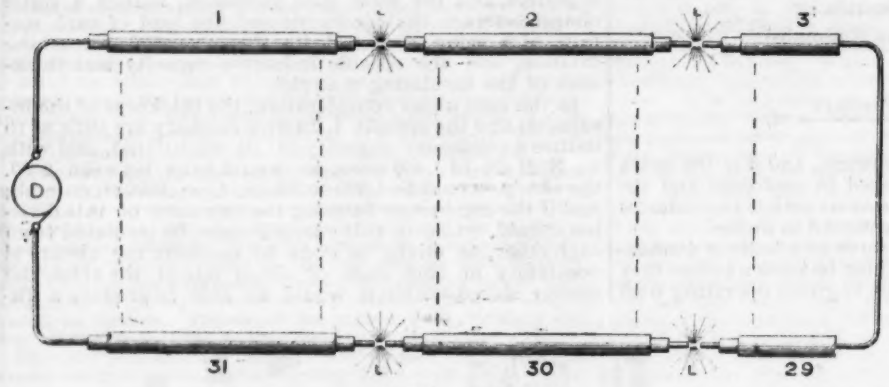


FIGURE 1

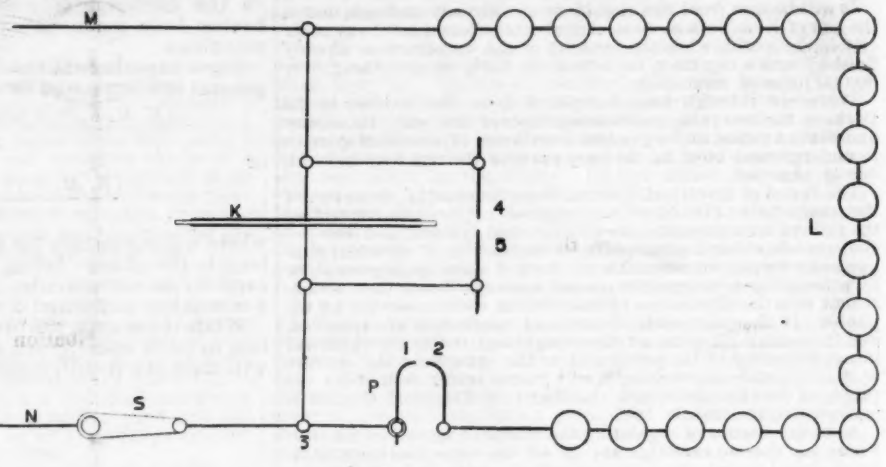


FIGURE 2

EFFECTS OF DISRUPTIVE DISCHARGES IN UNDERGROUND CABLES.

While this simple arrangement illustrates the action and answers as a means of protection, it is evident that some device more durable and capable of adjustment would be preferable. A design meeting these requirements is shown in Fig. 4.

In the figure *A* is the lead covering, *I* the insulation and *C* the conductor. Mounted on the lead *A* and held in place by the band *V* is the metallic arm *P*, carrying at its outer end the pointed rod *R*. Another pointed rod *R'* is held by a projection on the ring *B*, which is mounted on the insulating bushing *D*. A fusible wire *F* connects the ring *B* to the metallic sleeve or collar *E*. The distance between the points *R* and *R'* can be adjusted, and the rods held in position by suitable screws.

It is evident that the operation would be similar to that of the device shown in Fig. 3. The electrical potential between the conductor *C* and the lead covering *A* before attaining a height sufficient to discharge through the insulation *I*, will discharge across the air space between the rods *R* and *R'*, for these rods being in electrical connection with *A* and *C*, will attain their potentials, and the points of the rods will, according to a known law, have an electrical density above that of *A* and *C*, or that requisite to produce a discharge across the intervening air. The fusible wire *F* is inserted as protection against injury to dynamos and cables in case of a ground existing on the other side of the circuit.

There are several points, apparently trivial, but really of much importance, relating to the design and material of construction of a device for discharging a cable.

The distance, measured on the exposed surface, separating the points of support of the discharging arms or rods, should be as great as possible, as there would be a loss of

These tests show the superior strength of the insulation in the more condensed or homogeneous forms, and the weakening effect of much bending.

In this connection it may be well to inquire more fully into the tendency of the discharge to occur at the terminals of the lead.

It is a well-fact that the greater number of the grounds or burn-outs that occur on arc-light circuits are at the terminals of the lead or at the joints, and it is precisely at these points that the charge, acting under well-established and familiar laws, would be most dense, and, owing to the presence of the edges or points for the electricity to flow from, the disruptive discharge will, under ordinary circumstances, take place between the edges or points and the conductor within the insulation. Owing to the special facilities offered at these places for the passage of the discharge, it is probable that in many cases burn-outs occur under the influence of a charge that would be unable to produce a discharge through the continuous portions of the cable.

In order to reduce the probability of a discharge occurring at terminals and joints, I would suggest that the lead, whenever cut, be made bell shape, in order that all edges or points be turned away from the conductor.

It may be appropriate at this point to consider briefly that vexed question, which way does the spark pass?

There is a relic of the past ages existing, to a greater or less extent, among those who are unfamiliar with the present state of electrical science, and which I have no doubt many, if not all, of you have heard. The favorite way of expressing it is thus: *The earth is the home of electricity and it is continually striving to get there by the quickest and shortest route.*

By this theory the electricity as represented by the spark would always jump from the conductor to the lead and thence pass to the earth.

It is plain to see the great weight this would have in an argument against the near approach of the conductor to the earth as is necessitated in the underground system of distribution.

The direction of the discharge is determined by the form or figure of the charged bodies and the character or signs of the charges on them, the earth playing no part, other than that of a conducting medium.

On an underground system there is, the moment before a disruptive discharge occurs, an unstable equilibrium between two points of the system, or rather of the conductors forming the system, and the insulations or dielectrics separating them. Through the line joining the points there is a strain produced by the difference of potential of the points, the tendency being to a neutralization of the potential differences. Against this strain is opposed the resisting power of the dielectric intervening (and usually consisting of the insulations on the conductors and the earth which separates them). The disruptive discharge that follows may be either from a conductor to the earth or the reverse, but in neither case is there the slightest quantity of electricity left in the earth as a result of the discharge. It is a transmission of energy from one

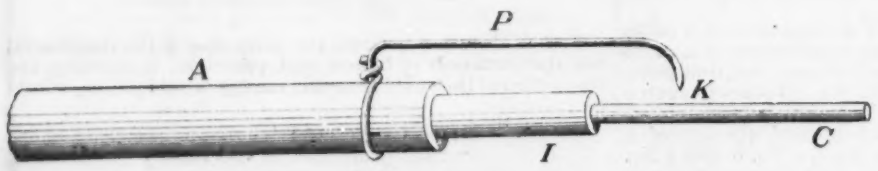


FIGURE 3

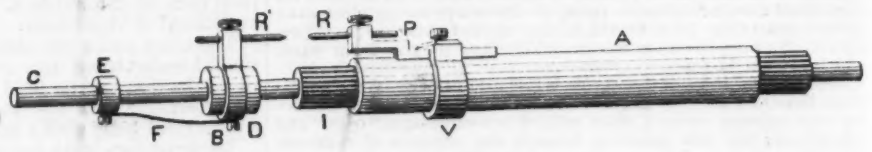


FIGURE 4

EFFECTS OF DISRUPTIVE DISCHARGES IN UNDERGROUND CABLES.

of 2,067 volts and a capacity in the circuit of .00822 microfarad.

While this demonstrates the minuteness of the path required for a discharge, it is hardly a parallel case to what would exist in an insulated conductor where the insulation was built up out of many overlapping windings of fibrous material, and then treated with an insulating compound, for in this case the cracks or crevice produced by temperature variations and the bending incident to handling and laying of the conductor will not be direct lines or planes from the conductor to the metallic casing, but angle or zigzag lines, following the interstices of the fibrous structure. This difference would result in the lengthening of the path of discharge, but scarcely to an extent sufficient to raise the resistance to discharge to the value of the insulating material in a perfect state; and so long as the value is below that of the insulating material, the value of the constant *a* is also lowered, and it is therefore reasonable to assume that the conditions may become such as to warrant an affirmative answer to the second question.

Unfortunately, both of the two grand divisions of conductor insulators, the fibrous and the non-fibrous, have their faults, for while the fibrous has the, in some circumstances, serious fault of cracking, the non fibrous energy across this space, in case the distance was small and dampness existed.

Another point to remember is that the constant *a* should have a known value, and, therefore, the most appropriate design for the discharger is one employing points to discharge from an unvarying intervening medium, such as air.

In order to obtain some definite information on the question raised by Mr. Leggett at the Pittsburgh meeting, as to the effect on the insulation of a short bend or indentation in the lead of a cable, I caused a very deep dent to be made in a cable, so deep in fact that it would at once have been condemned in practical work; and then connecting it into the working circuit, an attempt was made to cause a disruptive discharge to pass through the compressed insulation at the point of indentation, but the attempt was unsuccessful, the discharge preferring to occur at any other point.

Another experiment was made to determine the effect of bending the cable backward and forward several times in the same place. A length was selected in which the discharge always occurred at either one of the ends, and after the bending operation had been performed a number of times, I was able to produce the discharge through the bent portion in preference to the terminals.

point of the system to another, of a different potential, and the amount of electrical energy lost in the passage is expended in overcoming the resistance and appears as heat.

From the experiments and conclusions of Faraday I have made the following deductions.

1. When the charged bodies are of the same size and form the *spark discharge* will, other things being equal, be *from* the positively charged body.

2. Other things being equal, less potential is required to produce a *brush discharge* than a *spark discharge*, and when it does occur it will be from the negatively charged surface.

3. In all cases where the charge of electricity is on, or closely associated with, the discharging surfaces, a diminution of either surface will facilitate a discharge, and when any considerable difference exists in their areas, the discharge will always be *from* the smaller surface.

4. A spark from a small body to a large one will be from eight to ten times greater in length when the small body is charged positively than it would be with a negative charge.

In general the direction of the discharge between the conductor and the lead, through the insulation, is subject to the form of the surfaces of the conducting bodies; a slight burr or point on either one being sufficient to determine the direction of the spark.

In a series of very interesting articles by Mr. G. L. Addenbrooke in the London *Electrical Review*, the subject of spark length disruptive discharges and the advantages of a perfectly continuous and unbroken dielectric are extensively treated. The influence of the capacity of the cable is, however, entirely neglected. Special stress is laid upon the advantages of a continuous envelope of insulation, and those using rubber covered conductors are particularly cautioned against handling or bending them when the temperature is lower than 45 degrees Fahr., as fissures or cracks are then liable to occur and permit of the passage of discharges. This, I confess, was information to me and puts a certain limitation to the qualities I have given above to rubber, and which was written before this statement of Mr. Addenbrooke came into my hand.

As the experiments referred to in this paper have extended over a considerable period (not less than six months), there have naturally been a number of questions and points presented from outside sources. Others have been led into the field to experiment, and with the equally natural result of obtaining in some cases effects that they have construed to be at variance with those I have secured. I have one case in mind where the experimenters found it impossible to produce a disruptive discharge so long as the lead of the cable was insulated from the ground; but the grounding of it made the production of the discharge feasible and they concluded that the theory of a disruptive discharge was not correct. This is a repetition, under different conditions, of the very old experiment of attempting to charge a Leyden jar with the jar insulated. The first condition to be arrived at in the charging of a jar is the grounding of one of the surfaces.

A disruptive discharge through the insulation of the cable cannot occur without a charge being first formed; hence it is absolutely necessary that a ground be made to the lead.

The resistance of the ground connection to the lead, is to a very great extent immaterial, as the charge is cumulative, and the energy expended in the discharge is only that held in the charge, hence though the ground resistance may be many megohms in value, and the charging process extend through a considerable time, there will eventually be a storage of energy on the surface of a value sufficient to rupture the insulation at the first change in the charging current.

The spark discharge is all but instantaneous in its action, and with the word restricted to this immeasurably short space of time, it is necessary to have the energy on hand, as it were; there is no time to generate it,

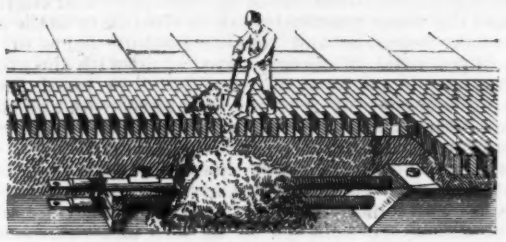


FIG. 3.—CHENOWETH CONDUIT.

electrically, at the dynamo and convey it over long or even short distances.

The subject of disruptive discharges with various resistances and self-induction placed in the path of energy, is beautifully treated in a paper read by Dr. Oliver J. Lodge before the Society of Arts, April 17, 1888.

One word more before closing this subject. It is safe to predict that, the disruptive discharge being provided for, little or nothing more would be heard of the much talked-of pin-holes in the lead, and the moisture-absorbing terminals; the undergrounding of arc light cables would become a thing of certainty, and our municipal governments relieved of a great bug-a-boo.

The following paper was then read by Mr. Alex. Crawford Chenoweth:

DESCRIPTION OF AN UNDERGROUND CONDUIT.

The changing of electric light conductors to an under ground system having engaged the attention of this meeting, I will place before you a method of constructing ducts that can be so arranged as to meet many of the objections heretofore presented. The object of this paper is not for the purpose of discussing the merits or demerits of systems that have already been presented, but to invite your criticism of the practical points of the method I am about to describe.

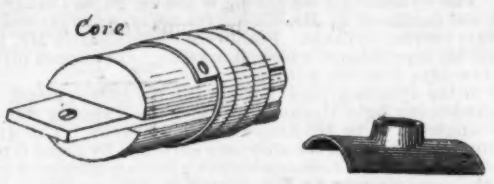
Assuming the subject of insulation has been settled and that an arrangement of the conductors in a structure permanently located, and so contrived that as demands from time to time are made for its use, it can be augmented at a small cost, this being done in order to meet the financial question of cost. The material from which to build these structures must withstand the forces of nature that are brought into action in their new relations. I have found that concrete, a mixture of Portland cement and sand in suitable proportions, well incorporated, answers all the requirements. The form of the structure requires a system consisting of ducts 4 inches in diameter with large manholes located at convenient points, for purposes well established in previous discussions, with other entrances to the ducts, through openings located at intervals, to be used when required as connecting points to houses and stores. All parts to be of smooth interior, free from joints, faults, depressions and water-tight.

The structure is formed by means of a core which consists of a wooden cylindrical rod, made in length of 14 or 20 feet, being cut in two, forming two half cylinders. The space removed by sawing through the rods, when each of the halves are placed together, is occupied by an iron rod, having a thickness equal to the portion removed by the saw, thus restoring the cylindrical shape; this forms the mandrel or core shown in Fig. 1.

Now, a ribbon of galvanized iron one inch wide, and of a thickness equal to No. 27 gauge, is wound spirally around the mandrel of wood, from end to end, securing the ends with a fastener to the wood, to prevent unwinding. The outside of the core is now painted with a mixture of clay, powdered soapstone and water.

The core thus described is ready for use. Preparing a ditch, the core is placed in it, resting on cross-pieces of wood; if more than one duct is to be constructed, other cores are ranged side by side. The concrete, in a plastic state, is now tamped well around, Fig. 3, bringing the top to an even level. The iron rod is now removed, Fig. 4, as well as the pieces of wood on which the ends of core were resting, and also the fastenings of the ribbon ends. The wooden half cylinders are now drawn out, leaving the spiral casing, which remains for several days.

A new core is inserted in the end of the spiral, the ribbon of the old core is fastened to the ribbon of the new core by a swivel, and we proceed in the same manner as before, thus constructing several hundred feet with the casing remaining in the ducts. When the cement hardens the casing can be drawn out. Fig. 5; being a spiral, this can be done at any opening, man-hole or unfinished portion of the work. As the spiral ribbon is removed, the surface coating of clay and soapstone adheres to the interior of the duct, producing a smooth surface, and acts as a lubricant to reduce friction when conductors are drawn in, and thus preserving the insulation.



FIGS. 1 AND 2.

This construction insures a monolithic structure of smooth interior, straight, free from joints, depressions, and water-tight by reason of its construction. At the same time, in case one should require another duct, the wall on one side is always ready, by merely placing a core on top or on either side, and proceding in same manner; this reduces the cost of the duct. The most convenient arrangement for distribution purposes suggests a line of two holes on each side of street, with man-holes at intersecting streets, and openings at every house lot subdivision.

I have adopted an opening in the form of a cast-iron nozzle, Fig. 2, with a hole into which pipe can be screwed by removing a screw plug, the same being set in the cement when constructing the duct, leaving the nozzle projecting only. This can be modified to suit any size or shape by replacing the nozzle with a box having a lid. This form of construction will permit the conduits to be placed near the surface; the elasticity of concrete enables it to withstand the blows caused by heavy traffic. It is an easy matter to project aconduit of this form from a man hole to an insulated point, and afterward to construct others alongside at small cost. The cost of constructing ducts by this method is narrowed down to the winding of the ribbon on the mandrel, the labor of removing the mandrels in the trench, removing the ribbon from duct, and rewinding the ribbon on bobbins.

As each part of the core is preserved and used an indefinite number of times the cost of the core is charged to cost of plant, it costing ten cents per foot. The winding of the ribbon is done on the spot as fast as wanted, and costs five mills per foot; the cost of drawing out the ribbon and rewinding on bobbins, using an ingenious device that removes all twists, costing about one mill per foot. The labor for removing wooden mandrel in trench is about one cent per foot. A duct, 4 inches in diameter made of concrete, 1 part cement, 2 parts sand, can be made for four cents per foot, including entire cost, exclusive of excavation, man-holes and openings. In case a repair should be found necessary, a block can be made with a duct through it, and inserted between the two ends thus to be joined, leaving a space of one inch at each end. Insert a spiral sleeve inside of duct made of iron, a wire fastened to the end of the ribbon forming the sleeve, also connected to the sleeve at the other end of the block by wire, then extend to nearest opening, pack the cement between the ends firmly, the sleeve preventing the cement from entering conduit. When the cement forming the joint becomes hard, the sleeves can be removed by hauling on the wire at the opening and removing the same.

On motion of E. T. Lynch, Jr., it was voted to appoint a committee to examine and report upon the underground wire question. Adjourned till 2:30 P. M.

AFTERNOON SESSION, THURSDAY, AUG. 30.

A communication from Mr. C. J. Field was read, inviting the members to inspect the lighting arrangements of the new Broadway Theatre. Also one from the Shultz

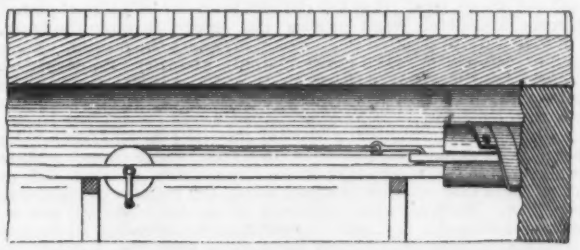


FIG. 4.

Belting Company to inspect a belt at the East River Electric Company's station.

The discussion on the underground question was then resumed.

In answer to an inquiry Mr. LESLIE said: The schedule of rentals for the New York conduits is $1,000 per mile per annum for a 3-in. duct, $800 per mile per annum for a 2½-in. duct, $750 per mile per annum for a 2-in. duct, $550 per mile per annum for a 1½-in. duct. I will say that with regard to the 2-in. duct I am not clear whether it is $750 or $650, not having the data.

Mr. De Camp thought that until underground wires had been proved thoroughly successful overhead wires should not be interfered with.

Mr. T. C. Smith referred to his successful attempts with lead-covered cables in Philadelphia, and considered that method a practical plan.

Dr. Moses advocated a centralization and consolidation of interests such that practically *power* alone should be distributed at one uniform potential through the city, and then converted into any desired current at the place of consumption. This would greatly simplify the matter.

The President then appointed Dr. Liebig on the Committee on Installation and Insulation in place of Professor Elihu Thomson, resigned. The following gentlemen were appointed a committee to report on recommendations contained in the President's address: Messrs. Steuart, Mason, Morrison, Weeks and Stanley.

The following revised constitution was then adopted.

CONSTITUTION.

ARTICLE I.

Name.

The name of this association shall be The National Electric Light Association.

ARTICLE II.

Membership.

SECTION 1.—Any individual or member of a company or firm operating an electric light, power, heat or welding station for public or commercial purposes; and any individual or member of a company or firm manufacturing electric supplies or apparatus, may become a member of this association by the payment to the treasurer of one year's dues.

SEC. 2.—Electricians, electrical engineers, and those whose professsion or business is directly related to electrical interests or to the commercial application of electricity, may upon the recommendation of the executive committee and a two-thirds vote of the association, become members thereof, by the payment to the treasurer of one year's dues.

SEC. 3.—Upon the unanimous recommendation of the Executive Committee and the approval of a two-thirds vote of the association, persons may be made honorary members of the association, with all the privileges of membership, except the right to vote.

ARTICLE III.

Officers.

SECTION 1.—The officers of the association shall be a president, two vice-presidents, a treasurer and a secretary, and an executive committee, to consist of the above-named officers, *ex-officio*, and nine other members.

SEC. 2.—The president and vice-presidents shall be elected by ballot to serve from the close of the annual meeting at which they are elected until the close of the next annual meeting.

SEC. 3.—No person shall be eligible for the office of president or vice-president for more than two successive terms, but this shall not be construed to forbid the election to the office of president of one who has served as vice-president.

SEC. 4.—The secretary and treasurer, who may be one and the same person, shall be nominated by the president, subject to confirmation by the executive committee. The salary of the secretary shall be fixed by the executive committee.

SEC. 5.—The executive committee shall be chosen by ballot at each meeting, either annual, semi-annual or special, and hold office from the close of the meeting at which they are elected until the end of the meeting at which their successors are chosen.

SEC. 6.—The treasurer, secretary and executive committee shall make written reports at each meeting, which reports, upon

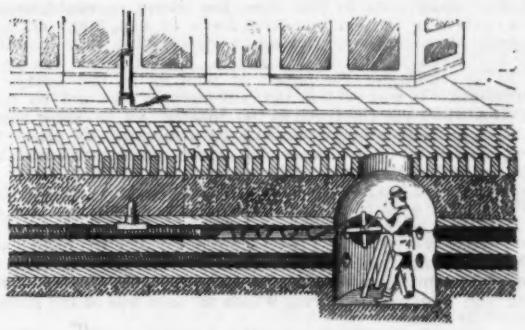


FIG. 5.—CHENOWETH CONDUIT.

their acceptance, shall be spread upon the records of the association.

SEC. 7.—The executive committee shall be the governing body of the association. They shall meet at the call of their chairman, from time to time, and shall report upon applications for membership, shall gather and prepare information upon topics of interest, and shall arrange for their discussion at the several meetings of the association. Five members of the committee shall constitute a quorum.

ARTICLE IV.

Meetings.

The annual meeting of this association shall be held in February, and a semi-annual meeting may be held in August of each year, at such places as the association shall determine, and on such dates as may be determined by the executive committee.

ARTICLE V.

Dues.

The annual dues shall be $20, payable in advance, and shall cover the calendar year.

ARTICLE VI.

Ballot.

On any question before the association a ballot may be demanded by ten of the members present.

ARTICLE VII.

Amendments.

SECTION 1.—Amendments to the Constitution shall be presented in writing and referred to a committee to be appointed by the chairman before being acted upon by the association; a two-thirds vote of those present shall be necessary to their adoption.

SEC. 2.—No amendment shall be voted upon on the day of its first presentation.

A. F. MASON,
G. M. PHELPS,
GEO. F. PORTER,
HENRY D. STANLEY,
} Committee.

THIRD DAY, FRIDAY, AUGUST 31.

The meeting was called to order at ten o'clock by President Duncan. The Committee on Transportation reported that they had been unable to secure concessions from the railroads for this convention. A new committee was appointed, with Mr. G. F. Porter as chairman. Mr. Frank Ridlon then read the report of the Committee on "Insurance Exchange," giving details of the method pursued by the Boston Electric Exchange and of reduced rates granted by the New England Insurance Exchange to licensees of the former. The report was accepted and ordered filed, and the committee continued.

The President then appointed the following committee to report on Underground Wires: Messrs. E. T. Lynch, Jr., C. H. Barney, H. C. Davis, W. C. Kerr and F. B. Crocker.

Mr. Arthur Steuart then submitted the following resolution, which was unanimously adopted:

Resolved, That the National Electric Light Association, after a full discussion of the subject, decide to express their hearty sympathy with the views expressed by his Honor, Mayor Hewitt, in his address before the Association upon the subject of putting wires underground, and in addition desire to take this opportunity of expressing the opinion that up to the present time no commercially practical method has been brought to their notice by which high tension direct currents such as are used for arc lighting can be placed underground.

Dr. P. H. Vander Weyde's paper was then read by Mr. Steuart, as follows:

THE COMPARATIVE DANGER OF ALTERNATING VS. DIRECT CURRENTS.

It is only a few days ago that I received the flattering invitation to appear before this meeting of the most eminent electricians of the United States, and present a paper containing my conclusions about the comparative danger to life lurking in the alternate and direct dynamo currents. I do so readily, as I have lately had the opportunity to become acquainted with the arguments made on both sides of the question. I was not prepared to do so when, a few weeks ago, I attended a meeting of the New York Board of Electrical Control, where several papers were read, most of them in opposition to Mr. Harold P. Brown, who had expressed himself in opposition to the use of the alternate current system, the introduction of which has lately been commenced. When the president of that meeting asked me to express my opinion I was compelled to decline, stating that my appearance there was solely as a listener to arguments upon the subject, about which I desired full information.

As some of the papers read there were written in such a spirit as to compel Mr. Brown to defend himself, I made up my mind to attend his expected defense, especially as it might give me an opportunity to hear what powerful arguments and facts would be brought out by the person who has put himself forward as the champion of the enemies of the alternate current system.

It always makes a painful impression upon me when I see that a scientific investigator feels the necessity of defending himself against personal attacks. The calling of the scientist should simply be confined to ascertain what is the truth. If he thinks he has detected erroneous conclusions arrived at by any colaborer it is his duty to expose them. At the same time, he must mind the old rule, *Suaviter in modo, fortiter in re;* therefore, above all, he must let the facts speak for themselves, avoiding any allusion regarding the capabilities or ulterior motives of his antagonist. In short, he must leave the use of all personalities to the politicians; for these the main considerations are *persons; principles* are secondary and may be changed to suit circumstances, or thrown overboard entirely. In science, however, we have, on the contrary, nothing to do with *persons*, but only with the ultimate *truth*, which we are all striving to arrive at.

At a recent visit to the physical lecture room of Columbia College, where I had been invited by telegram to hear the reading of a paper and a lecture illustrated by experiments by Mr. Harold P. Brown, the feeling referred to above was more painful to me than even the howling of the dog which was experimented upon. Dogs have for so many years been considered as the legitimate martyrs of science, especially under the hands of physicians and professors of physiology, that we have become more or less hardened in their regard. Nobody will deny the immense value of the increase of our biological and especially pathological knowledge obtained in this way.

A great portion of the paper read by Mr. Brown consisted in complaints about the personal attacks made upon his capability, as soon as he asserted in print that the alternate electric currents were more dangerous to life than the direct currents, namely, that a current of the electromotive force of, say, 300 volts alternate current, would be more likely to destroy life than double or triple that strength of a direct current. One feature was prominent in the reading of the paper as well as in the lecture and experiments. It was evident that the purpose was not so much to exhibit what was the truth in the matter as to show that he was right in what he had asserted. He attempted to prove this by experimenting upon a large dog, which, when subjected to a direct current, stated to be 300 volts, set up a short howl; 600 volts produced a longer howl and frantic efforts to escape from the cage, while a current of some 900 volts paralyzed the dog, who kept up a labored breathing. Then a representative of the New York Society for the Prevention of Cruelty to Animals interfered and forbade further trials of this kind, so that Mr. Brown was compelled to give the dog the *coup de grace* by applying the alternate current, which he said was of the strength of only 300 volts.

Unfortunately for Mr. Brown, this proved nothing, as the dog was already half dead by the previous successive and increasing direct current doses of 300, 600 and 900 volts respectively. Another dose of 300 or 600 volts direct current might in all probability have ended his life just as well. But what is more, his statement that the alternating current was merely 300 volts was not proved, as he himself had stated previously that reliable instruments for measuring alternate currents were difficult to obtain, and confessed that he had only a voltmeter for this purpose but no ammeter. After the lecture I examined the voltmeter and found, that according to the statements of Mr. Brown himself, its operation was based upon indications of rise in temperature.

Now, it is well-known that voltmeters based on this principle are based on false premises. Rise of temperature is not produced by electromotive force, but by amount of current; one Wollaston plunge battery cell, of one square metre acting surface, having, of course, the electromotive force of only one single volt, will produce far more heat than a series of 24 freshly prepared cups of a Leclanché battery of 40 volts electro-motive force. This pretended voltmeter was, in fact, a kind of ammeter.

This is so self-evident that Prof. G. Forbes, of England, who last year exhibited before the American Institute of Electrical Engineers in New York a meter for alternate currents, did not think of calling it a voltmeter, because its operation was also based upon rise of temperature, but he called it a current meter. This meter was described and illustrated in all the electrical journals at the time, where there was added a little table giving the observed currents in ampères. Immediately under that table follows the statement that Sir William Thomson complimented the author on having practically solved a problem on which he himself had been working without satisfactory results, thus indorsing the instrument as a current or ampèremeter. This shows that Mr. Brown was mistaken when he said he had no ammeter for alternating currents; he had one and supposed it to be a voltmeter. If he used it as such, what becomes of his statement that the alternate current he used was 300 volts.

And here I cannot let the opportunity pass by of repeating what I have been preaching for years, namely, that the voltage alone is no criterion in regard to the danger of a current; the danger comes only when the electromotive force (as measured in volts) is accompanied by a sufficient quantity or volume of current (as measured in ampères). An electromotive force carrying a current of only a few microampères may be as high as 1,000 volts without doing any harm (even when alternating, as proved by the Ruhmkorff coil). It behaves like water oozing out of a pinhole leak under pressure of hundreds of pounds; it can do little or no work. On the other hand, a very large volume or quantity of current with small electromotive force, of say a small fraction of a volt, will not have the power to pass through the human skin, or even through the liquids of the body, but only through metals (as proved by the thermo-electric pile). Such currents behave like a large volume of water in a lake, with little or no inducement to make it move; hence this will do little or no work.

Professor Mayer, of the Stevens Institute, Hoboken, in a lecture recently given to the members of the New York Electrical Society, the Electrical Section of the American Institute, exhibited some novel experiments, intended to measure, if possible, the voltage of static currents. He used an old-fashioned friction electric machine, and showed that the voltage of its currents ran into the thousands, while the ampères were so minute as to escape the possibility of measurement, with the means thus far at our disposal.

This leads me back to the subject of the experiments of Mr. Brown; he stated that the quantity of the direct current he used was only a fraction of one ampère. This induced me to examine also the ammeter after the lecture, when I found that the ammeter and voltmeter were coupled together in series in the same single circuit. Now every experienced electrician knows that in order to measure the capacity of a dynamo current in ampères, we must not place any other resistance in the circuit, much less the high resistance of a voltmeter, which may be 500 ohms, as then the indication of the ammeter may drop down 90 per cent. of the original indication; in fact, the ammeter indicated actually two-thirds of an ampère, as had been stated by Mr. Brown when he was asked during the lecture.

The manner in which the ammeter and voltmeter were used was considered by me in connection with the fact that, if really a current of only two-thirds of an ampère had been obtained, it would render the dynamical value of the three currents used only equal to 200, 400 and 600 watts respectively, which was incompatible with their effect on the dog. This caused me to go to the dynamo plant of Columbia College to inquire. I found that the direct current machine used was an Edison municipal dynamo of 15 ampères and 1,200 volts.

It is likely that Mr. Edison gave it the name of municipal in anticipation of the fact that the municipal governments will need such machines when the new law in regard to capital punishment and of dispatching criminals by electricity instead of hanging goes into operation next year. If so, it is very suggestive, in regard to the controversy we are discussing, that such an able electrician as Mr. Edison is satisfied that a direct current dynamo is all that is needed for that purpose without regard to the alleged greater effectiveness in this respect of the alternate current dynamos. This dynamo did not belong to the Columbia College plant, but it was furnished by Mr. Edison for the occasion, as well as an alternate current dynamo. Both were removed after Mr. Brown finished his experiments, which, it appears, he continued privately for a few days after the lecture.

One of the dynamos used belonged to the college plant; it was an incandescent light dynamo, of which the capacity was stated by the engineer to be 125 ampères and 110 volts. This dynamo was employed to obtain the alternate currents, by using it to feed the field magnets of a Siemens-Halske alternate current machine, after the usual manner, as represented in the engraving (exhibited), which shows the essentials of the arrangement used, only with this difference, that the field magnets of the Siemens alternating machine were supplied by the direct currents obtained from the much larger 125 ampère dynamo referred to, in place of the small one represented in the engraving.

The kind of apparatus which was used and the nature of their arrangement for the production of the alternate current makes it very unlikely that it would produce a current of only 300 volts, especially when we take into consideration that the current developed must represent some kind of equivalent for the horse-power required; firstly to drive the 125 ampère incandescent light dynamo; next, that required to drive the alternate current dynamo. The latter must have considerable power, as the 125 ampère current was more than sufficient to saturate the great number of its stationary electro-magnets. According to the statement of the engineer, the engine driving the 125 ampère dynamo requires 36 h. p., that of the alternate dynamo 36 h. p.; together 72 h. p., which, at 746 watts per h. p., gives 54,712 watts. If the ampères of such a current had been measured after the method employed by Mr. Brown for the direct current, it would have resulted in 54,712, divided by two-thirds of an ampére, or 82,063 volts.

Of course, this is an exaggerated estimate, but sufficient to show the worthlessness of all the figures as given by Mr. Brown. In order to come to correct conclusions it would be necessary to measure, by means of indicator diagrams, the engine-power utilized, and measure the currents obtained by proper instruments, properly used and conscientiously observed. One thing is certain, namely, that the dynamos used were not of such a defective quality as to warrant the supposition of such an enormous loss of the power applied, as would be the case if only an electromotive force of 300 volts had been obtained.

I must also not omit here to state that if Mr. Brown had known the proper quarters where to apply for apparatus to determine properly the voltage and ampères of alternate currents, he could have been provided, and his labors in this direction might have had some value.

There was added on the lecture room table another important additional (however small) contrivance, for the right understanding and use of which I will have to make a short introductory explanation. I do this, also, because I have been especially requested to do so by several parties who had become interested in the operation of this, to them, very novel device.

I must ask pardon to bring some elementary considerations before this learned body, but my apology is that this paper will be published and read by many who are not so well informed about electrical subjects, and whose ideas upon it need some clearing up.

Every one who has handled faucets attached to pipes from which water can escape under pressure, will have noticed that when suddenly shutting off the water, a blow like that of a hammer is produced in the pipes. This is caused by the momentum of the water when in motion (often very improperly called inertia), and which shows itself every time this motion is arrested. On this peculiarity is based a contrivance in which, by the automatic alternate opening and closing valve, a small portion of the water discharged may be raised to a greater height than that of the original device which produced the pressure. This contrivance has been called a hydraulic ram, and by its help an increase of pressure may be obtained at the expense of a certain quantity of water.

Notwithstanding electricity is not a fluid like water, it behaves, however, also in this case, in a similar manner. At the moment a uniform electric current is suddenly interrupted, a current of greater electromotive force (more pressure) is developed in the conductor, and will show itself as a spark at the break of contact, and as a shock through the body when the hands have hold of the wires when the contact is broken. It is a very old observation, and one of the earliest reminiscences of my boyhood (about 1823), that the current from say 30 pairs of plates, scarcely perceptible when closing the circuit through the body, will give a quite sensible shock when breaking the circuit. Such currents have been called extra currents, and they are, of course, stronger in proportion to the strength of the original current, and still further increased by inductive influences, when there are coils in the circuit.

As it may be desirable for special purposes to eliminate these currents, an apparatus has been invented, which operates like a very sensitive relay, and then leads these extra currents off, or shunts them into another channel after the manner of lightning protectors. Such an apparatus was on the table during the experiments with the dog, and appeared to be intended to protect the animal against the effect of these extra currents. I must confess not to see why this was done except for the purpose to annul the most powerful and most dangerous item connected with the direct current. Therefore I consider the addition of this contrivance improper if we wish to arrive at the truth in regard to the comparative danger of the alternate and direct currents, because in case of accidental exposure of person, there is rarely such a safeguard inclosed in the circuit, and the person struck by the current must submit to the extra current as well.

In order to arrive at the truth of the matter we must also, above all, be able to make definite statements about the voltage and the volume of current, based on precise measurements, which, in regard to the alternate currents, could not be furnished but was only guessed at.

Finally, as far as I can judge about the matter, guided by the present state of knowledge (especially in regard to some, in many respects, still unexplained peculiarities in the behavior of alternate currents), I should say that their true voltage must be quite high. They do not behave like currents of low voltage (say 300 or 400), as they can be, and practically are, conducted over much longer lines and thinner wires than is the case with the direct currents of, say, 1,000 volts. This fact is acknowledged as well by the enemies as by the friends of the alternating current system. Experiments made by converters, especially with a new and very peculiar one of my own construction, appear also to show that there must be considerable voltage in the alternate currents so as to account for the generation of the enormous volume of current into which the electromotive force is converted; in other words, for the thousands of ampères obtained by the conversion of the volts of the primary current, and for which ampères there is no ammeter yet to measure them, but their volume shows itself in the capacity to perform operations requiring the highest temperatures, such as welding iron, fusing the most refractory substances, etc.

Surely no dynamo could be constructed directly generating a current of such volume, as it would destroy itself by the heat of its own current; it is only by alternating current machines of high voltage, assisted by proper converters, that currents of such great volume and high caloric capacity can be obtained.

After all, we must not lose sight of the main object of this controversy, which is the comparative danger lurking in the two systems. When it is found by experience that actually the danger of being killed is greater by the use of alternate currents, it does not make any difference if the voltage which does the killing is 300 or 1,300.

When, however, we consider that statistics show that the loss of life by the direct current system is continually increasing in proportion that the system is extending, the probabilities appear to be that both systems will furnish their equal quota of victims, and the labor of comparing the relative danger of both systems, and especially the discussion about their comparative voltage, appears to become an idle occupation.

In brief discussion on this paper, Dr. O. A. Moses, referring to a letter of ex-Gov. A. B. Cornell published in the daily papers, advocating the prohibition of high tension currents, offered the following resolutions, which were unanimously adopted:

Whereas, The National Electric Light Association read with some uneasiness the persistent effort of rival interests to educate the public to a distrust of high potential electric currents, and

Whereas, They would protest with all energy against recent efforts to pit against each other continuous and alternating current systems of electrical distribution, which efforts have as their covert purpose the destruction of the harmony of action now existing between them, and

Whereas, This association for mutual protection recognizes distinctly the danger of unfair legislation such as has destroyed the electric lighting interest of Great Britain; therefore be it

Resolved, That the National Electric Light Association emphatically declares that it is beyond doubt possible to produce and distribute high tension currents for public use without any more danger or difficulty than attends the distribution of gas and water in our dwellings; and further be it

Resolved, That they would impress all legislators with the fact that success in the electric light and power business is based chiefly upon economy in the size of conductors, and that to utilize this fact high tension currents were adopted in the first stages of development of electric lighting and have been used ever since and will continue to be used; and further, be it

Resolved, That it is our conviction that there is no difference in the danger attending the use of continuous or alternating currents, and that both may be so transformed before being used as to render them perfectly harmless and tractable means of distributing electric power for use in cities.

The following paper was then read by Dr. G. A. Liebig, Jr.:

SOME METHODS OF ELECTRICAL MEASUREMENT.

Among the requirements of modern electrical engineering and the usual practical work in electricity is the ability to make accurate and reliable measurements of current, of potential, of capacity, etc. And with the growth of practical electricity itself goes hand in hand the increasing necessity of instruments of precision and standard apparatus with which the various appliances in every day use may from time to time be compared.

It may not be out of place, therefore, to give a brief account of some methods of measurement and comparison, many of which have been thoroughly tested, and one or two of which are believed to be new and more reliable than the methods hitherto applied. Let us discuss first of all the best manner of measuring *currents*.

Current determinations may very conveniently be divided into two groups, *i. e.*, the measurement of heavy currents and the measurement of small currents. Of the latter very little need be said, as the best method undoubtedly depends upon the use of an electro-dynamometer, and the most suitable form of such an instrument is that of the British Association, the well-known Weber electro-dynamometer, which has been thoroughly explained and mathematically treated at length by Maxwell. With two or more electro-dynamometers of this kind, currents, ranging from a few milliampères to 10 or 25 ampères, can readily be measured with an accuracy of one part in two or three thousand. Currents greater than this must be determined by some other arrangement, since a dynamometer capable of accurately measuring very heavy currents would have to be of massive proportions and of correspondingly increased cost. An instrument at the Johns Hopkins University, which is intended to measure currents up to 15 ampères, has fixed coils one meter in diameter.

For heavy currents it has been found advisable to apply the method of "fixed resistances," a method which has been used and successively improved in several electrical exhibitions in this country and abroad, and the range of which is practically unlimited. In this method the current to be measured traverses several heavy German silver bars which have been hard soldered to a pair of very large copper blocks to which are fastened in the same way the terminals of the galvanometer leads. The bars and end blocks are immersed in a tank of refined petroleum, and their temperature, by stirring constantly the oil, can be determined to a few hundredths of a degree. To use this apparatus a known current, measured by an electro-dynamometer, is sent through the fixed resistance, and the potential at the ends determined by the galvanometer joined at these points. The deflection of the latter corresponding to any other current, gives us at once a measure of the current. In practice, a resistance-box is placed in circuit with the potential galvanometer, and the resistances are always adjusted until approximately the same deflection is obtained. By doing this we render ourselves independent of the assumption that the angular deviation of the galvanometer needle is proportional to the current, except for exceedingly small differences. It is to be noticed, however, that the calibrating current is measured by an electro-dynamometer, and not by a galvanometer, the reason being that the former is independent of the value of H (the earth's horizontal component), whereas any error in the determination of H appears directly in the galvanometer constant.

During the measurements the oil in the tank is constantly stirred and its temperature noted. As a matter of fact this is found to change but little even with currents of 200 ampères or more. Calling R_0 the resistance of the German silver bars at 0° C; β their temperature coefficient; T_1 and T_2 temperatures of the same corresponding to currents C_1 and C_2; D_1 and D_2, r_1 and r_2, t_1 and t_2, the deflections of galvanometer, adjusted resistances, and their temperatures, respectively, corresponding to currents C_1 and C_2 we have

$$C_2 = C_1 \frac{D_2\,(1 + \alpha\, t_2)\, r_2\,.\, R_0\,(1 + \beta\, T_1)}{D_1\,(1 + \alpha\, t_1)\, r_1.\, R_0\,(1 + \beta\, T_2)};$$

α being the temperature coefficient of the resistance box.

The terms relating to changes of the resistance R_0, *i. e.* of the German silver bars, can generally be neglected.

POTENTIAL MEASUREMENTS can be made in exactly the same general manner, the "fixed resistance" used for this purpose being, however, very much higher. A known current is passed through the German silver reel, forming the fixed resistance, and the deflection of the galvanometer, joined to its ends, is noted. A resistance box in circuit with the galvanometer enables us to reduce this deflection to a convenient angle. Care must be taken that the current used for calibrating the galvanometer be so small as to heat the fixed resistance as little as possible. After the calibration is completed, the galvanometer is joined to points whose electromotive force we wish to measure and the resistance box adjusted until the same deflection as before is secured. We have then an expression for the potential, of exactly the same form as the one given before. For very high potentials the method is inapplicable and recourse must be had to an absolute electrometer of the kind first described by Sir William Thomson. In this instrument, fully explained in Thomson's papers, the difference of potential between two points is measured by the attraction between two discs electrified to the same difference of potential, one of them being balanced by a series of weights, the other being fixed. With such an instrument electro-motive forces varying from 1,000 volts to over 100,000 volts can easily be measured, and it thus offers an excellent means of comparison with electrostatic voltmeters, etc.

There is, perhaps, no better way of measuring RESISTANCES than by the employment of some accurate and sensitive form of Wheatstone bridge. The only difficulty encountered in such measurements is the exact determination of the temperature of the various resistance coils and standards in use during the work. It has been found absolutely necessary to immerse all the measuring coils in liquid during the use of the apparatus, and to allow them to remain in a room whose temperature is almost constant several hours before any measurements are made. Even thin glass tubes containing mercury and surrounded on all sides with cracked ice have been found to require at least five or six hours for their temperature to fall to zero.

The efficiency of dynamos and motors can be determined with all necessary accuracy by means of any one of several dynamometers of distinct types, and now well known, and the subject is one which presents no difficulty whatever until the attempt is made to measure the efficiency of very small machines; that is, machines of one horse-power and less. In these cases it has become necessary to devise a way of measuring which shall greatly reduce errors ordinarily encountered. The difficulty generally presented is that the dynamometer itself absorbs in friction so much energy that the loss thus occasioned amounts to a large proportion of the total activity of the machine under examination. The cradle dynamometer is perhaps free from this objection, but it must be rejected on account of the uncertain but large errors introduced by slight errors of centering. Hopkinson's method might be employed, were it not that it requires two machines to experiment upon; an obstacle which in most cases would be a serious one. A method which appears to be devoid of the objections just enumerated is a modified calorimetric method. To employ this the motor or dynamo, as the case may be, is surrounded by an air-tight water jacket, through which circulates a stream of water at a uniform temperature. The dynamo is allowed to run under a given load until all the effects of heating have become constant; this includes the heating resulting from mechanical friction, and from the current itself. After this the flow of water is determined, its temperature carefully noted, and from these data the losses occurring in the motor are at once deducible. There appears to be nothing in the way of making the method universally applicable to small machines, and the indications are that its adoption would lead to very accurate results. This method was first proposed by Dr. Duncan as a means of measuring the efficiency of alternating current converters.

Several methods of determining the magnetic qualities of iron and steel have been published. They all depend upon the measurement by a ballistic galvanometer of the induction through a coil wound about the specimen to be tested, either when the coil is moved, the current reversed, or reduced to zero. These methods offer no difficulty, and a ballistic galvanometer can easily be calibrated in absolute measure by the use of an earth inductor or even a coil of wire of a few turns, its constants having been determined by measurement and simple calculation.

Mr. Arthur Steuart then made an oral report of the committee on patent legislation, and stated that the bill submitted by the committee to Congress had been favorably reported upon for immediate passage by the committee to which it has been referred. The committee was continued and the treasurer was authorized to receive subcriptions to the patent legislation fund.

Mr. E. R. Weeks then read the following paper on:

ELECTRICAL EDUCATION.

The signs of the times point to a growing interest in electrical education. In the rapid development of the applications of electricity, the demand for skilled workmen far exceeds the supply, and both employers and employés are beginning to realize that the men at hand must be assisted to a mental culture, whose lack is one of the drawbacks to perfect service.

In response to a few remarks made on this subject at the Boston convention, I have received so many letters of inquiry as to the ways and means of acquiring knowledge which will be of practical value to the workmen, that it may be profitable to outline a plan that has proved its working value to employés of all grades of educational advancement, the greater number of whom, however, had previously had so little commerce with books as to be almost helpless before a small library.

When the full measure of the utility of electricity has been reached, and when schools have had time to understand the needs of electrical engineering, the work of the college will afford all the preparation that theory can give. Already good courses in this line of investigation have been added to the curricula of many universities. With this branch of the subject we are not at present concerned. But it may be said in passing, that the practical work in the factories, which is intended to supplement the college course, is not sufficient to make a man an electrical engineer. So great has been the demand for "expert" service, that many new-fledged bachelors of science have been rushed through factories and sent out to do work requiring *manual dexterity* and an *intimate practical knowledge* of the operation of apparatus under widely varying conditions. Before the student enters the factory he should have taken his degree, and should have spent at least a year at central station work, where he may learn to use his hands and may become familiar with many varieties of trouble and gain an experience which will render the factory course of greater value to him. However, our immediate concern is how to help the army of raw recruits that the youth and rapid growth of our industry necessitates, to most quickly acquire an intelligent, practical working knowledge of the service.

The mutual improvement society organized among the employés of the Kansas City Electric Light Company has learned numerous lessons in regard to proper methods, useful books and the use of them, and in order to open the discussion on this phase of electrical education, I have consented to outline the work of that society. In 1885 the company provided a commodious reading-room, and a large audience room, fitted with a library, paper files, black boards, tables, writing materials, etc. Some half dozen electrical papers and magazines are here on file, and the library now contains over 100 volumes. (See list.)

Twenty-five of these volumes, chosen with an eye to simplicity, served as a nucleus to which additions have from time to time been made. The selection of books for first use was an important work, as many texts are gotten up in a style and nomenclature entirely beyond the taste and reading ability of the ordinary dynamo, lamp and line man. The officers of the company made it a point to talk with the men on various subjects treated in the periodicals and books and to call attention to articles that might be helpful. Other things being equal, those who showed in their conversation that they had been studying, were first promoted. The librarian has kept a record of the books taken out, which shows that next to the unabridged dictionary, the one in greatest demand has been "Electricity in the Service of Man," by Dr. Alfred Ritter Von Urbanitzky. Almost every member of the society has read it and some several times. Next in popularity stand "Elementary Lessons in Electricity and Magnetism," by Thompson; the works of Gordon, Holmes and DuMoncel, on "Practical Electric Lighting," and "Electricity—Its Theory, Sources and Applications," by Sprague. Several copies of each of these works had finally to be provided to meet the frequent calls. Men in all branches of the service read them and find that their perusal results in great benefit. A recent addition to the library, F. M. Kimball's "The Dynamo—How it is Made and How to Use It," whose simplicity and brevity will commend it to every workman, bids fair to become the most popular book with beginners. "Short Lectures to Electrical Artisans," by Fleming; "Elementary Treatise on Electric Batteries," by Niaudet; Hospitalier's "Domestic Electricity;" Brennan's "Electricity and Its Discoverers;" Jeans' "Lives of Electricians;" "The Electric Motor and Its Applications," by Martin and Wetzler; "Electrical Measurement and the Galvanometer," by Lockwood; Day's "Electric Light Arithmetic;" "Dynamo Electric Machines," by Thompson; and Pray's "Twenty Years with the Indicator," are also favorite works.

The more purely theoretical treatises are taken out by few, but the number of their readers is gradually increasing. Among the more recent publications, there is one book deserving special mention. It is Mr. Hering's "Principles of Dynamo-Electric Machines," which for its clearness, accuracy and subject matter should be in the hands of electrical readers of all classes.

The success of the reading room soon led to the organization of the Gramme Society, and the work of its members shows that the men are learning how to read. There was, at first, a little opposition to it among the men, some of whom objected to giving away the information which they had gained by hard knocks against experience. But this feeling has gradually died out and all have come to realize that, in the words of one of our linemen, "This is a case where one can give away his cake and eat it too." An additional inducement to membership was offered by establishing a relief fund in the society, to which each member subscribes at least twenty-five cents a month, the aggregate monthly subscription being doubled by the company. In case of sickness or disability of any member, he receives his pro rata share of the fund and more should the society so decree. So that now, although the membership is not compulsory, most of the men in the service of the company have joined.

The meetings were formerly held on Sunday afternoon, but Tuesday evening was finally selected as a better time. The organization is one of the simplest, and there is no membership fee. The officers are elected annually, and a committee, appointed by the chair, chooses the subjects and leaders of discussion under the advice of the general manager, who endeavors to so direct the whole work that a reading of current electrical literature shall be necessary to the intelligent hearing of the various talks. Care is taken to assign each topic to those who have had the most practical experience in regard to it. Among the subjects already considered are "A Talk on Magnets," "Early History and Sources of Electricity," "The New Light," "Technical Terms," "Electrical Units," "Ohm's Law," "Shunts," "The Arc Lamp," "The Incandescent Lamp," "Carbons," "Construction and Maintenance of Lines," "Danger from Shocks," "Grounds, Crosses and Short Circuits," "Lubrication and the Proper Care of Journals," "Various Types of Dynamo-Electric Machines," "The Edison and Thomson-Houston Machines—Their Construction and Proper Care," and "The Alternating Current System." The discussions of some of these subjects required several meetings. In addition to the working topics, a biographical sketch of some noted scientist, especially an electrician, is given and is found to awaken a deeper interest in electrical study. The discussion of the subjects is both theoretical and practical, and the speakers have been led to a free use of the black-board for synopses, diagrams and illustrations.

The beginnings of the work were rather disheartening, and it required a great deal of enthusiasm and patience on the part of its inaugurators to induce the men to take any useful part in the exercises. It was only by continual questionings and references to books and periodicals, by pointing out the advantage to be derived from the perusal of this or that article in this or that paper or book, the constant recognition of the good work of each speaker, and the ignoring of the weak and useless, that the men were gradually encouraged to take hold of the subjects in a free and easy way, and to give up the cream of their experience without fear of losing it.

But the results have amply repaid all efforts, and the growing interest of the members, their anxiety for perfect equipment, and, above all, their ready expression of the advantage which the necessary reading and the interchange of thought have been to them, are most gratifying proofs of the wisdom of the movement.

Those members of the society whose information lay chiefly in a practical direction, have added to that information and have gained a knowledge of some of the principles underlying our industry. They are thus deriving more pleasure from their work and are on the way to a higher and wider field of usefulness. Those whose information was mostly of a theoretical nature have clinched such information and have acquired a more intimate knowledge of the apparatus used, and are thus better prepared to discharge the duties devolving upon them.

The benefits of this work to the company are evident in the improved condition of all parts of the service, and in the interest which the employés take in perfecting it—an interest which has grown out of the dawning preception that the company has at heart the good of its workmen, as well as the increase of its dividends.

LIST OF BOOKS IN THE LIBRARY OF THE GRAMME SOCIETY.

Alglave & Boulard—The Electric Light, History, Production, etc.
American Electrical Directory.
Anderson—Lightning Conductors.
Atkinson—Static Electricity.
Ayrton—Practical Electricity.
Benjamin—Age of Electricity.
Blakesley—Alternating Currents.
Bottone—The Dynamo—How Made and How Used.
Braunt & Wahl—Techno-Chemical Receipt Book.
Brennan—Electricity and its Discoverers.
Browne—Fuel and Water.
Buel—Safety Valves.
Colburn—Steam Boiler Explosions.
Cooke—The New Chemistry.
Cotterill—Applied Mechanics.
Cumming—Introduction to the Theory of Electricity.
Day—Electrical and Magnetic Measurements.
Day—Electric Light Arithmetic.
Deschanel—Natural Philosophy.
DuMoncel—Electric Lighting.
DuMoncel—Electricity as a Motive Power.
DuMoncel—Incandescent Electric Lights.
DuMoncel—Electro-Magnets.
Dyer—Induction Coils.
Everett—Elementary Treatise on Natural Philosophy.
Faraday—Experimental Researches in Electricity.
Fiske—Electricity and Electrical Engineering.
Fleming—Short Lectures to Electrical Artisans.
Gordon—Physical Treatise on Electricity and Magnetism.
Gordon—Practical Treatise on Electric Lighting.
Gordon—School Electricity.
Haskins—The Galvanometer.
Hering—Principles of Dynamo-Electric Machines.
Holmes—Practical Electric Lighting.
Hopkinson—Dynamic Electricity.
Hospitalier—Domestic Electricity.
Hospitalier—Modern Applications of Electricity.
Jeans—Lives of Electricians.
Jenkin—Electricity and Magnetism.
Kapp—Electric Transmission of Energy.
Kempe—Hand Book of Electrical Testing.
Kimball—The Dynamo—How It is Made and How to Use It.
Lockwood—Electrical Measurement and the Galvanometer.
Lockwood—Electricity, Magnetism and the Electric Telegraph.
Lommell—Nature of Light.
Maier—Arc and Glow Lamps.
Martin and Wetzler—The Electric Motor.
Maxwell—Electricity and Magnetism.
Monroe and Jamieson—Pocket Book of Electrical Rules and Tables.
Niaudet—Elementary Treatise on Electrical Batteries.
Noad—Students' Text Book of Electricity.
Plante—Storage of Electrical Energy.
Pray—Twenty Years with the Indicator.
Prescott—Bell's Electric Speaking Telephone.
Prescott—Electricity and the Electric Telegraph.
Proceedings—The Association of Edison Illuminating Companies.
Proceedings—The National Electric Light Association.
Pynchon—Chemical Physics.
Radau—Wonders of Acoustics.

In the discussion, Dr. Moses referred to the industrial school now in New York, in which electrical education for artisans is the chief aim. Mr. Foote also referred to a scheme of organizing a circulating library among electric light stations.

Mr. E. T. Lynch, Jr., offered a resolution that a committee be appointed to suggest to our colleges a course of instruction in practical electric lighting. The President appointed the following gentlemen: O. A. Moses, E. R. Weeks, A. R. Foote.

On the recommendation of the committee appointed for the purpose, Chicago was designated as the next meeting place of the association, and the following were elected as the executive committee: B. E. Sunny, chairman; S. E. Barton, W. A. Kreidler, O. A. Moses, J. F. Morrison, E. T. Lynch, Jr., F. Ridlon and E. F. Peck.

Mr. Steuart read the report of the committee on the recommendations in the President's address and offered the following resolution, which was unanimously adopted:

Resolved, That this Association shall hereafter have a permanent office in the City of New York, which shall be in charge of an expert electrical engineer, who shall be the secretary and treasurer of the Association, and that the president at once take steps to procure the services of such a person and establish him in suitable quarters and with suitable facilities in this city.

On motion of Dr. Moses a vote of thanks to Secretary Harding was passed unanimously.

On motion of Mr. DeCamp a resolution was adopted as follows:

Whereas, The value of capital is determined by the profits realized thereon; and

Whereas, The risks attending the business of electric lighting make it pre-eminently necessary that its capital be surrounded with such safeguards as will protect it against illegitimate competition; and

Whereas, The practice of parent companies of furnishing apparatus and capital for the establishment of plants in cities and towns where local capital has already been invested, is a growing evil; therefore, be it

Resolved, That the Association denounces such practice as detrimental to a common interest and recommends its members jointly and individually to suppress it, even to the extent of discriminating against all systems which persist in such practices.

Mr. H. L. Lufkin then read the following paper on

A BASIS FROM WHICH TO CALCULATE CHARGES FOR ELECTRIC MOTOR SERVICE.

The theoretical side of the electric motor question has been very ably presented to and discussed by this association, but thus far the practical side has been somewhat neglected.

It will be my purpose in this paper, if possible, to show that there is a general average controlling the use of machinery which it will be safe for electric light and power companies to follow in making their charges for motor service, rather than adopt an arbitrary price per horse-power, regardless of the character of service required of the motor.

I have arranged what might be called a power curve, representing the approximate average actual service in electric motors in connection with the several classes of work represented in the list accompanying the diagram.

This curve is calculated on motors which are only of sufficient capacity in each case to carry the full load. If the motor should be larger than is necessary to drive the machinery, the percentage of actual service will of course drop below that shown in the diagram.

By adopting a basis of averages which shall be general among members of this association, the charges for a constant horse-power of current may vary with the circumstances of its first cost in each case, but the general classification of motor service may be a comparatively fixed rule. I am not prepared to say that this is the best plan to follow, but respectfully submit the following as a possible solution of the frequently asked question, How shall we charge for electric motor?

Exhaust Fans.

First on the list of power consumers is the exhaust fan, taking it in average use. There are, however, circumstances under which its use will be limited to as low as 70 or 75 per cent. of its contract hours of service. As, for instance, in a dining room it may be cut out except during meal hours, or entirely cut out on cool days. In places of this description, however, its contract use is usually limited to three or four months in the year, and other than electric power is, by circumstances of first cost and inconvenience, but a feeble competitor. The first four applications on the accompanying list, viz., exhaust fans, blowers, ceiling fans and fan outfits, are all more or less subject to the foregoing conditions, and therefore current supplied to motors for these purposes commands the maximum price per horse-power. One important feature in the installation of ceiling fans is the countershafting to the motor. In one recent case we had a complaint from a customer that the ½ h. p. motor sent him would not drive two ceiling fans, and that the motor must be defective and should be return it for repairs. We immediately sent a representative to find the difficulty, which was found, as is usual in such cases, in the counter-

shafting, or rather the want of it. The 3 in. pulley on the motor was connected to a 6 in. pulley on the line shafting. The rated speeed of the motor was 2,000 revolutions, and had it been able to develop this speed would have driven the line shaft 1,000 revolutions and the fans a relative speed. To accomplish this would probably require a motor of 3 or 4 h. p. The line shafting driving ceiling fans usually runs about 75 revolutions. To give this speed on the line shaft with a rated speed of 2,000 on the 3 in. pul'ey of the motor would require a countershaft with a 24 in. pulley belted to the motor. On this same countershaft should be a 5 in. pulley belted to a 15 or 16 in. pulley on the line shaft. Fully three-fourths of the trouble found in electric motors arises from improper shafting and belting. The average make of 30 in. exhaust wheel, a ⅛ h. p. motor should drive at about 400 revolutions. Say then the speed of the motor is 2,000 and the pulley 3 in., it would require a 15 in. pulley on the fan to do the work; a 36 in. wheel requires 1 h. p. to develop the same speed. If the motor speed is 1,800, the pulley 4 in., it would require an 18 in. pulley on the fan to do the work. These are the most popular sizes of exhaust wheels.

The next application on the list, open tank elevator pumps, commands the highest price for current per h. p. in the motor of any elevator application. The methods of operating the open tank hydraulic elevators in question are undoubtedly familiar to you all. Instead of the usual steam pump a power pump of some approved design is substituted and connected to the motor by suitable countershafting to give the required revolutions at the pump. The regulation of the motor in this case should be controlled by the position of water in the lower tank, as in the case of the steam pump. And in this connection let me suggest the necessity of great care both in installation and insulation. On all installations in basements and cellars, or elsewhere, where there is the slightest tendency to dampness, raise the motor off the floor on a suitable frame or stand, and build around it, on all sides of possible approach, a low platform, using glass insulators as legs or standards to support it. So arrange this that the motor or its connections cannot be reached except when standing on this insulated platform, and the liability to a shock will be reduced to the difference of potential between the terminals of the machine. To return to the subject. Let us take for an illustration an elevator using 120 gals. of water per trip, and consuming one minute in making its entire up trip, or about two per round trip. The lower tank or water supply is on a level with the pump. The upper tank is 70 ft. above the pump, and in the piping to the upper tank are five elbows. For each elbow add 2 ft. to the elevation, or an approximate total elevation of 80 (ft.) × 120 (gals.) gives us 9,600 foot-gallons. This amount would be required every two minutes if the elevator was in absolutely constant operation, or 4,800 foot-gallons per minute × 8½ gives us 40,800 foot-pounds. This we must at least double to allow for friction in pump, shafting, etc., making 81,600 foot-pounds, or about 2½ h. p., say 3 required in the motor.

This class of elevator is confined almost entirely to passenger use, therefore the service required of the motor is much more constant and the margin between the h. p. hours contracted for and the h. p. hours of actual service much smaller than in any other elevator use, excepting possibly the services in connection with pressure tank elevators in the more popular office buildings. In this case we have a maximum average use of 80, and instances, such as the hotels, small office buildings, etc., where the service will not exceed 60 of the contract h. p. hours. In order, however, that the electric light company shall derive the greatest benefit from this inconstant service the installation and wiring should be the best and only the most approved and economical apparatus employed.

The next application on our list, pressure tank pumps in connection with elevators, represents a somewhat smaller percentage of horse-power hours of actual service in the motor as compared with the possible horse-power hours than in the case of an open tank pump. In case of the pressure tank the water reserve is usually limited and the motor therefore must be equal to the continuous operation of the elevator at maximum load. Taking this fact into consideration and the circumstances of elevator use being about the same in this case as in case of the open tank elevator, we have a greater ratio of difference between the possible or contract horse-power hours in the motor and the horse-power hours of actual service, the maximum average use being about 70 per cent. to 75 per cent. and the minimum as low as 35 per cent. to 40 per cent., depending, of course, on the character of building in which the elevator is employed or the character of service. In calculating the size of motor required on an elevator of this description a very convenient fact to remember is that every pound of pressure per square inch is equivalent to lifting water about 23 feet, or about 230 feet per 100 pounds pressure. By reducing the required pressure to a relative lift in feet, and knowing the amount of water required by the elevator per minute, the motor calculation becomes the same as in case of the open tank elevator, the same allowances being made for friction, etc., as in the first case. The regulation of the motor in this case should be accomplished by the conditions of pressure in the pressure tank, as is the case with a steam pump employed in this service.

The next application of importance on the list is sewing machines. In the tests I have been able to make on this class of work I have obtained some singular results. One item of importance is the fact that the single thread machines, which are the lightest running, command the most power in operating. Paradoxical as this may seem, it is easily explained. As a rule this class of machine is used on light work, such as shirts, ladies' underwear, etc., and operated at a higher speed than any other class of machine. At equal speed the volts consumed on a single thread machine as compared with a shuttle machine is about as 2 to 3. In average commercial use, however, the positions are reversed, and the ratio of volts consumed in the single thread, as compared with the shuttle machine, is about as 5 to 3. To double the speed on a sewing machine requires about 2½ times the power. The difference in volts consumed on the different makes of sewing machines is so small that we may disregard it entirely, as well as the character of work done by the machine, for the heavier the work the slower the speed and more frequent and longer stops on the machine, thus keeping the average volts per operator about constant in all cases. This leaves the speed in stitches per minute at the sewing machine the factor from which we must calculate the power required in a sewing machine plant. To illustrate this, I will give you the record of two cases which are about the average. Case No. 1 is a shop in which are thirty sewing machines connected to a two horse-power motor. At the time the tests were made there were but twenty operators are work, leaving ten idle machines, the entire shafting however being in operation. The class of goods manufactured in this shop is a cheap grade of cotton and wool pants, rather heavy goods to sew. A voltmeter across the terminals of the motor gave the following readings with a current of 9 ampères: Minimum, 90 volts; maximum, 148 volts; average, 119; which gives us a minimum average per operator of 4 5 volts, and the maximum average of 7.4 volts, or a general average of 5.9 volts per operator. This motor was driving the shafting for 30 machines, and as the average operators employed the year round will not exceed 75 per cent. of the shop capacity it will, I think, be entirely fair to estimate the average volts per machine rather than per operator, as the user of the motor has contracted for power sufficient to drive his entire plant. In this case then we have a minimum average of three volts per machine and a maximum of 4.9 volts, or a general average of say four volts per machine. A two-horse motor of 82 per cent. efficiency with nine ampères of current will require about 200 volts to develop two actual horse-power. Two hundred volts, therefore, is what the electric light company contracts to deliver while in reality they deliver only 129 volts, or 60 per cent., or a minimum average of 90 volts, or 45 per cent. of the power contracted for. These machines were making about 1,200 stitches per minute, an average of four volts per 100 stitches.

Case No. 2 is a shop in which are 32 machines running at about 1,200 stitches, each being supplied with an individual motor of ⅛ h. p. capacity, and the class of goods manufactured being men's summer clothing, such as white duck vests, flannel coats and vests, etc., the duck from which these vests are made being about as hard work on a sewing machine as can be found. In this shop were 24 operators at work. The maximum volts in this case was 116 and the minimum 40, or general average of but 78 volts, or about 2½ volts per machine with four more operators than in the first case, in which we had an average of 119 volts. This shop has been paying the electric light company $32 per month for more than a year, which is the price the same company charge for current for a 4 h. p. motor which approximates 400 volts, which the company contracts to deliver. This gives us a minimum average use of but 10 per cent. and a maximum of 29 per cent., with a general average of 19½ per cent. In other words, the company is saving in this shop the price of a ⅛ h. p. motor each month, besides making a profit on the volts actually delivered. On a contract for three years the electric light company would be money in pocket if they would present the customer with 30 small motors, charging him $1 per month per motor for current, rather than let him buy a 2 h. p. motor to operate the same machines, with the necessary shafting, at a charge of $18 per month for current. Taking this average in case No. 2 of 2½ volts per machine, from a 50-light machine we could run not less than 900 sewing machines, or about 18 to the arc lamp. At $1 per month per machine an income of $900 per month would be derived from a 50-light machine without any lamp expenses, such as carbons, repairs on lamps, globes, etc. On the average, in case No. 1 of 4 volts per machine, we could operate but about 562, say 600 machines. Divided up in shops of 30 machines and a two h. p. motor to each shop, we would have 20 two h. p. motors. At a charge of $18 per month each we would have an earning capacity of but $360 per month from the same 50-light machine.

This is but one page from the thus far unwritten history of the much maligned small motor. Still the question is frequently asked: "Can we sell current for $1 per month for a small motor driving a sewing machine and make a profit?" As a matter of fact, 50c. per month for small motors driving sewing machines yields a better profit to the company supplying the current than $10 per month per h. p. in large motors to drive the same machines, besides the immense advantage which the small motors possess of keeping the circuit in much better balance, the fluctuations due to the stopping and starting of large motors being at times a serious matter. One electric light company, making rather a specialty of these small machines, rents the motor and supplies the current for $1.25 per month per sewing machine, and reports that at this price the motor service pays them a better

AVERAGE PERCENTAGE OF MOTOR POWER USED IN DIFFERENT INDUSTRIES.

The next two applications, picture frame manufacturers and molding manufacturers, are very similar. Their busy seasons, as a rule, are in the spring and fall, and also follow closely any activity in house building. In the case of the larger manufacturers in this line a maximum average of 75 per cent. will possibly be reached, but probably never exceeded. In the case, however, of the picture dealer, who has a small shop in which he makes picture frames and moldings to order, the actual service of the motor will fall as low as 25 per cent., or 30 per cent. of its contract hours; one case in our experience the actual service having reached this low average. A fair general average in this class of work would be about 60 per cent.

The next application, nickel and silver platers and buffers, are good contract customers as a rule; one case in our experience showing but an average use of 20 per cent. of the contract horse-power hours. This, however, is probably an exceptional case, and as near as we can estimate on this class of work the actual motor service will not exceed in any case 60 per cent. of the contract hours; a fair average being probably 45 or 50 per cent.

The next two applications, printing presses on news and job work, are probably met with more frequently than any other.

A more striking illustration of the advantages to the electric light company in the subdivision of power into the smallest possible units it would be hard to find. There is a difference in efficiency of from 15 to 20 per cent. in these two sizes of motors, but this difference is fully lost to the large motor in driving the shafting, and the small motor still has the advantage of being out of circuit entirely when the machine it is driving is stopped. There is scarcely a manufacturing industry which does not possess its busy and dull seasons. This means that in no industry will over 75 per cent. of the machines or machinery employed be in average operation. The entire shafting in the shops must be kept in operation the entire year often for less than 50 per cent. of the machinery. Subdivide these same shops into as many small units as possible, and the current necessary to operate the shafting for this idle machinery will be saved, besides the saving from frequent stops while the machinery is in active use.

To return again to the list, the next two applications, picture frame manufacturers and molding manufacturers, are very similar. Their busy seasons, as a rule, are in the spring and fall, and also follow closely any activity in house building. In the case of the larger manufacturers in this line a maximum average of 75 per cent. will possibly be reached, but probably never exceeded. In the case, however, of the picture dealer, who has a small shop in which he makes picture frames and moldings to order, the actual service of the motor will fall as low as 25 per cent., or 30 per cent. of its contract hours; one case in our experience the actual service having reached this low average. A fair general average in this class of work would be about 60 per cent.

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On exclusively news work, the instances where the motor is in service more than 3 or 4 hours is rare. It is however usual in news offices to find two or more job presses. If the newspaper printed happens to be a morning paper the hours of news work are usually between 12 midnight and 4 o'clock in the morning, the job work being done through the day. I have in mind a case of this description. In the shop is one cylinder press and three job presses connected to a 2 h. p. motor. This motor is on an incandescent circuit of 110 volts. To develop its rated power at 110 volts would require about 16 ampères in the motor. An ampère motor in series with the motor while running off the morning paper with only the cylinder press in operation, stood at 12 ampères. For three hours this load was practically constant when it was thrown off entirely. This gave on the night service but 30 per cent. of the contract hours. This motor required 5 ampères to drive the shafting, and but 8 ampères, or 1 h. p., to drive the three job presses with the cylinder press off. Here then is but a 50 per cent. use if the presses be used constantly; there are, however, many days when they are comparatively idle, 30 to 40 per cent., thererefore, is a very safe estimate of the maximum use of this motor on the day circuit, or had the motor been a 1 h. p., which would have been sufficient to drive the job presses, the use would be 60 to 80 per cent. of the contract hours, probably not above 60 per cent. All printing offices will probably come within this range unless the motor be larger than is necessary to do the work.

Machine shops doing principally lathe work as a matter of course use a larger percentage of their contracted power than shops doing lathe and bench work with the same hands. In no case will the service of the motor exceed 65 per cent. or 70 per cent. of its contract use, for machine shops, like sewing machine shops, will never average over 75 per cent. of the shop capacity for operators the year round. The average, especially in the case of a shop doing much bench work, will fall as low as 40 per cent.

The driving of laundry machinery, which is our next application, usually proves a profitable contract, according to reports. This fact arises from the intermittent use of the machinery. The heaviest service on the motor will probably be found during the early part of each week, with a general falling off in work during the summer months, while the patrons of the laundry are away at the seashore or in the mountains. In this application, therefore, a 75 per cent. service would probably be an exception, with probably many instances where the service would fall below 50 per cent.

The next application, model and pattern makers, are small users of power, as their occupation requires a large proportion of hand work. Fifty per cent. service in the motor will be found a fair average maximum use, with instances as low as 20 or 25 per cent.

The next application, direct power or belt elevators, is another application frequently met. The average service in the motor is also much smaller than in any other elevator application. Let us suppose a case of the familiar grip connected to the ordinary hand hoist with a lifting capacity of 2,000 pounds. In this case the motor is in use only going up, and the usual break is used in coming down. Connected to this elevator in the loft of the building we have a 5 h. p. motor wired to a cut-out on the ground floor. We will call the lift 45 feet and the time consumed per trip 1 minute. We will allow 60 full trips of the elevator at full load at 2,000 pounds per trip each day. This would approximate ten car loads of merchandise handled by the elevator, which is certainly above the average. This motor, we will say, is on a ten-hour day circuit, its possible horse-power hours, therefore, would be 5 h. p. for ten hours, or 50 h. p. hours per day. Sixty trips of one minute each gives us exactly one hour's service of the full 5 h. p., or 5 h. p. hours. To drive the shafting only while the elevator is coming down or idle would require about 150 volts, or 1⅓ h. p., and if this was in constant operation the balance of the day, nine hours, its total use on shafting would be 13⅓ h. p. hours, which, added to the 5 h. p. hours, gives us a grand total of 18⅓ h. p. hours, or 37 per cent. of the contract hours. If, however, the user of the motor avails himself of the cut-out box and cuts the current out when the motor is not in use, the average use would drop to 20 or 25 per cent. instead of 37 per cent. In the case of a direct power passenger elevator, the use might possibly run up to 60 per cent., but this would be exceptional.

Coffee mills will average from 40 to 60 per cent. of their contract hours, manufacturing jewelers about the same, while retail jewelers will run as low as 25 per cent. Ice cream freezers will not average over 25 per cent.; but as the contract season in this case is usually short, they should be rated at least a 50 per cent. basis, except, possibly, in cases where the customer pays the cost of installation and wiring which is usual in these cases.

A dentist is one of the smallest of power users, so small, in fact, that if every one in a city were connected with a circuit the load from this cause would never be felt. We will, however, put them down at from 10 to 20 per cent.

The optician uses a motor to turn his grain stones, and its use in this case will average from 20 to 30 per cent.

The last application on the list, church organs, use only from 10 to 20 per cent. of the contract service.

These are, of course, but few of the very many applications of the electric motor, and if, as I trust, the possible subsequent discussion of this general plan may establish a basis for rating motor applications, not only will the object of this paper be obtained, but a question of considerable annoyance now existing between the motor man and the Electric Light and Power Company will be solved.

In conclusion, Mr. Chairman, I beg to suggest that the supply and rates of charge for electric power have become of sufficient importance to this association to be represented by a permanent committee, whose duty it should be to obtain from the different members of the association, as far as possible, their experience in the supply of power, in such manner and form as shall be deemed by the committee best suited to the wants of this association.

The discussion was opened by Messrs. Colvin and Harding, the latter of whom called attention to the field which opened up profitably in the supply of power to electric roads from light stations.

Mr. RIDLON reported from New England his experience to be that of the previous gentlemen in favor of motors of the larger size as compared with small motors.

Mr. REDMAN stated that he was operating 296 motors at Rochester.

Mr. LAW said that the strain on dynamos did not seem to be so hard on the machines as indicated by Mr. Lufkin. His company merely furnishes current, but does not take care of the motor. Once a month they inspect and measure current.

The PRESIDENT remarked that he was disappointed in the meagreness of the discussion on the subject, as it was one of the most important which they had to deal with.

Mr. RIDLON stated that the power sold gives far less discounts and trouble, inspection, etc., than the light, in the ratio of 20 to 1.

Mr. GARRATT figured that it would require 30,000 horse-power hours to run one car for one year, or about $800 per annum.

Messrs. ALEXANDER and CRAM, President and Secretary of the New England Electric Exchange, corrected some of the statements contained in the committee report on "Insurance Exchange."

Mr. STEUART moved the addition of Messrs. Alexander and Cram to the Committee on Insurance Exchange, which was adopted.—Convention adjourned

EXHIBITS.

The Sawyer-Man Electric Company, of New York, made an extremely pretty and effective display in Parlor 5 of their incandescent lamps, fixtures, fuses, cut-outs, etc. The lamps were shown arranged on a large board in tasteful designs, below which the letters "S. M." were spelled in miniature lamps. This exhibit was kept running all the time by means of a Thomson-Houston machine driven by a small Baxter motor in the hotel, the motor getting its current from the Brush up-town station several blocks away in West Twenty-sixth street. The novelty and the beauty of the exhibit were such as to keep the parlor crowded throughout each day.

The Callender Insulating and Waterproofing Company were installed in Room 34, where they exhibited some very interesting samples of their solid underground system The pieces shown exemplified the system as in actual use in some twelve cities in this country and in several places abroad. The same solid system is also to be used for the feeders of the new Edison plant in Minneapolis. The Trinidad line wire and other specialties were also on view.

The Simplex Electrical Company, of Boston, exhibited in Room 33 their well-known insulated wires for all classes of electrical work; also their patent Simplex tree insulators.

The Thomson Electric Welding Company showed in Room 33 three large boards, on which were grouped a great many specimens of their work in the welding of pieces of similar and dissimilar metals, such as shafting, chains, tubes, pipe, tool steel, brass rods, etc.

The Okonite Company, of New York, made an extremely pretty and effective display in Parlors 11 and 12, of their well known wires and cables. The exhibit included all their leading and familiar specialties, and special attention was directed by visitors to the lamp cord and new improved Candee line wire. They have lately introduced a new specialty called okonite tubing, which is largely taking the place of the common rubber tubing heretofore used. The merit of this may be judged when it is stated that it has received one of the strongest possible indorsements from insurance authorities. Another interesting part of the exhibit was the display of submarine cables for electric lighting, telegraph and telephone use. They have already gone extensively into service, and their qualities are such as to insure a very general adoption for them. The company's agents visiting for the occasion were: Messrs. F. E. Pettingell, of Boston; C. E. Trump, of the Novelty Electric Company, of Philadelphia; E. V. Cherry, Standard Electrical Works, Cincinnati; W. H. McKinlock, Central Electric Company, Chicago.

The Standard Underground Cable Company had an exhibit in Parlor 13. It comprised their various lead covered wires and cables, for the different purposes. A striking novelty was shown in Acheson's electric light cable terminal for connecting the cable with the pole line of the lamps or as a testing station between sections of cable. With the help of this terminal the cables would appear to be thoroughly protected from disruptive discharges.

The Union Indurated Fibre Company, of New York, exhibited in Parlor 2 a number of their specialties in the fibre, for electrical use, such as battery jars, boxes for storage work, underground conduits, etc.

The Stilwell & Bierce Manufacturing Company showed in Parlor 2 a fine group picture, illustrative of their "Victor" turbines, so many of which are now being used in electric light work.

C. McIntire & Co., of Newark, displayed in Parlor 2 a case containing samples of their special joints and connections for use in telegraph, telephone and electric light circuits.

The National Carbon Company, of Cleveland, established themselves in Parlor 2, where they made themselves agreeable by distributing to the delegates copies of their new directory of arc lighting plants, both central station and isolated. The directories were greatly prized and in the briskest demand. They can be had free on application to the company personally or by letter.

The Schenck Belt Holder and Shifter Company, of New York, had a model of their ingenious beltholder, on exhibition in Parlor 2.

The E. P. Gleason Manufacturing Company made, in Parlor 15, their usual handsome display of all their electric light specialties, glassware in globes, shades, etc. A special new fixture, with shade, was shown with large incandescent lamps for street service. It is waterproof, with an opal glass reflector and metal top.

The Baxter Electric Manufacturing and Motor Company occupied Room 130. It was the intention of the company to make a fine working exhibit, but the sad lack of accommodations at the hotel forbade this. There were shown, however, a large number of photographs which illustrated many of the plants in which the Baxter motors have now been installed.

The E. S. Greeley & Co. made a display in Room 132 of their various electrical supplies, especially those relating to electric lighting. The exhibit included the Cardew voltmeter, for which Mr. Goodyear reports a very active demand.

James W. Queen & Co., of Philadelphia, filled up Room 131 with a very fine and complete display of their instruments for test and measurement of all kinds, whether for laboratory, station or individual use. The method of using the instruments was practically shown, and the attendance was large throughout the meeting.

The New York Insulated Wire Company had their headquarters in Room 17, where they exhibited the Grimshaw wires and cables and their other insulated goods, including more especially the new line wire for electric light purposes.

The Western Electric Company were located in Room 16. Special conveniences were there provided for telephoning, for the free use of the delegates. This was highly appreciated, and was in constant use.

The Sprague Electric Railway and Motor Company had one of their motors on view in Room 38, showing the new ring arrangement for easy and continuous oiling.

The Campbell Electrical Supply Company exhibited their "Vulcan" wires and cables in Room 39.

Mr. C. K. Giles exhibited in Parlor 3 his well-known anti-magnetic shield for watches.

The American Waltham Watch Company had an exhibit, in Room 130, of its non-magnetic watch, with special balance, hairspring and escapement. Various experiments were made before the visitors to show the effect of magnets on ordinary watches and the absence of effect in watches provided with the Waltham protection above mentioned.

The Phœnix Glass Company made a tasteful display of their beautiful glassware in Rooms 11 and 12.

Mr. J. B. Crouse, of the Standard Carbon Company, said during the convention that his company are turning out 60,000 carbons a day at the present time and are far behind their orders. The average number of carbons turned out for the year ending July 15 was 1,300,000 a month. They have now increased their facilities so that they can manufacture two millions a month, and they expect next Winter to run up to their full capacity. With regard to the recent troubles in the management of the company, Mr. Crouse stated that at the hearing before Judge Hamilton, as to an injunction, on Aug. 20, after the statements had been made on both sides, Mr. Boulton was ordered to transfer his lease to the Standard Carbon Company. An application was made by Mr. Boulton at the same time to have a receiver appointed for the company, but this was denied by the court.

Mr. T. Wallace had on exhibition in Parlor 3 a model of a new electric light conduit, in which there is to be what he calls "atmospheric insulation." The conduit itself is to be iron casting, insulated and rendered non-corrosive by a preparation of asphalt and silica, and to have spool insulators made of glass or porcelain.

The Electrical Accumulator Company, and the Electro Dynamic Company, of Philadelphia, had a remarkably attractive exhibit in Parlor 4 of storage batteries, plates in their various stages, switches, cut-outs and other special appliances for storage work. This development is still somewhat new to many of the members, and the greatest interest was shown by them in the inspection of the batteries.

The Bernstein Electric Manufacturing Company, of Boston, had a compact little display of its new series incandescent light in Parlor 4.

A handsome showcase full of non-magnetic watches made under the Paillard patents was shown in Parlor 4. The watches were handled and inspected by the delegates with considerable interest, and were put on trial in a manner which demonstrated their ability to run "against the field" of force.

Exhibits were made by the Eastern Cable Company, of Boston, of their Clark wires and cables; A. B. Laurence, of cotton leather belting; American Electrical Works, Providence, of insulated wires, cables, etc.; National Conduit Manufacturing Company, of New York, their conduit system; C. L. Ireson, leather link belting; Standard Paint Company, their paint specialties; the Grove Electric Company, of Philadelphia, their meter for lamp hours.

CONVENTION NOTES.

The members of the convention wore, as a general rule, neat little red and blue buttons issued by the Baxter Motor Company. These buttons served as a distinguishing mark in various ways. For instance, when the delegates called on Nero at Staten Island, and were invited by Mr. Erastus Wiman to enjoy the hospitality of the place, those only were allowed to respond to the invitation who wore the buttons. The other members being without such badges or similar means of identification, were treated with hauteur by the attendants as part of the populace, and went thirsty. In another case, the badge was taken in some way to be that of a detective. Mr. Alexander, while on the Staten Island boat, found a thief taking the time from him. The thief was surrounded by seven or eight of his gang, but when Mr. Alexander seized him and recovered his watch, they all fell back with the greatest agility and respect, and allowed their associate to be handed over to the authorities. They had caught sight of the blue gilt button, and in the half light had taken Mr. Alexander to be one of the authors of the *Evening World's* detective stories.

On Friday evening a couple of hundred of the delegates left by the steamer "Catskill" for Providence, to take part in the clam-bake given on Saturday by the American Electrical Works, and to proceed thence to Newport to spend Sunday, returning on Monday.

The *Western Electrician* and the *Electrical Engineer* had their quarters in Parlor 3; the *Electrical Review* and *Modern Light and Heat* in Parlor 4, and the *Electric Age* and THE ELECTRICAL WORLD in Parlor 2. It is needless to say that these parlors, serving as general reception rooms, were crowded at all times.

The Electric Club practically kept open house during the Convention, all the delegates having free entree on card from Secretary Harding. The hospitality thus offered was heartily enjoyed by a great many delegates, and will be one of the pleasantest recollections of the New York meeting.

During the course of the convention a great many hospitalities were extended to the delegates and their friends. On Wednesday evening a large party was taken by the *Electrical Review* to see "Nero," at Staten Island. The evening was favorable, and the occasion proved very delightful to all who participated. At the close of the performance, Mr. Erastus Wiman invited the delegates to partake of refreshments. On Thursday evening about 300 gentlemen, on the invitation of the Okonite Company, proceeded to the beautiful new Broadway Theatre to see Lillian Russell in the spectacular comic opera, "The Queen's Mate." The party occupied a large part of the parquet, and overflowed into the boxes. Neat gags alluding to the presence of the electricians were skillfully worked in during the performance, and these, with other chance expressions that fitted the occasion, were received with tremendous applause. After the play, under the escort of Messrs. Candee, Manson Wetmore, and other members of the company the party proceeded to the Electric Club, where a sumptuous collation was served. Dr. Moses and Dr. Mason made speeches eulogistic of the hospitality that had been shown during the evening, and felicitous replies were made by Commodore C. A. Cheever and Mr. Candee. Other speeches were made and the festivities were prolonged till about 2 A. M., when a spirited impromptu concert brought an extremely enjoyable evening to a close, and the delegates went back to the Brunswick feeling that if they had not painted the town red they had at least made an ochre night of it. Nothing could have exceeded the smoothness with which the programme was carried out. There was not a hitch. Every detail had been attended to, and every care was taken to make the members of the

party happy and comfortable. When it is remembered that the Okonite Company thus gave two entertainments at two different places within three hours, and that there was not the slightest untoward incident to mar the pleasure of the occasion, it will be admitted that thoughtful, free-handed hospitality could go no further.

After the adjournment of the Convention a large number of the delegates proceeded to the Electric Club. Arrived there, Mr. Duncan introduced Dr. Moses, who then, in the name of the donors presented Mr. Morrison with an ornamental box, with a base of silver, containing a gavel. The box was about 10 × 6 × 6 inches. On the base were the names of all the cities where the conventions had been held. In relief surrounding the box were Baxter motors, as well as constant current and alternating current machines for lighting. At one end of the box was a miniature incandescent lamp, and at the other end was an arc lamp. The gavel inside the box was of insulating material, and on it was Mr. Morrison's name handsomely engraved. The key of the box was of wire, and when the presentation was made, was so arranged as to open and close the circuits in the club-house. Mr. Morrison acknowledged the gift in a neat and happy speech.

Dr. Moses then called for Messrs. H. M. Byllesby and George Westinghouse, Jr., but neither was present, whereupon he tendered to the Westinghouse Company, through Mr. H. C. Davis, President of the Electric Club, a set of richly bound volumes, in a morocco case, containing the reports of the proceedings of the association from the beginning. This gift was intended to testify to the gratitude of the Association for the generous checks handed in to the funds of the Association by the Westinghouse companies at Pittsburgh, and for the many kindnesses received by the body while in that city last February. President Duncan and the Executive Committee of the Association were dined at the Club in the evening.

The Endowment of Genius.

A recent writer in *Lippincott's Magazine* puts forward an idea which, if it were practicable, and there is no reason to believe it is not, would conduce largely to the welfare of nations and would advance the material prosperity of all. Viewing with sorrow the early struggles of many men who have finally achieved greatness and have been pioneers in the sciences and arts, the writer advocates that upon the appearance of a great genius he ought to be placed in a position such that all the cares connected with the gaining of a livelihood should be banished from his mind, and he should be secured the use of his whole faculties for his chosen work. The writer goes so far, even, as to say that a country could well spend a large sum of money to find such geniuses, and cites the remark of Huxley that England could have afforded to spend £100,000 in the search for a Faraday. It certainly is a fact that men of great genius have generally little faculty, and less time, for making money, and that if they could be placed in such a position as is outlined above, their work would far exceed in originality and extent that which they might do when burdened with other cares, chiefly relating to money and the means of existence. It may be argued that many of our institutions of learning, with their well endowed chairs, supply this want, and they do to some extent, but it is not in this way that the writer would have his idea carried out. He would have a fund sufficiently large to enable him on whom it is to be bestowed to allow himself the freest action in every thing, unhampered by any cares or duties whatever. Such a state of existence would be an ideal one, and to prove that men of genius are by no means insensible to its benefits, and would not consider it in the light of an eleemosynary state of existence, we need only cite the case of the great musician Wagner on this subject, who in some recently published letters complained that his existence was made painful by the struggle for a competency, and that the world ought to provide him with sufficient means to allow his faculties and fancies free scope for their full development.

The Mechanism of Electrolysis by Alternating Currents.

It is considered as an established fact, say MM. J. Chappuis and G. Maneuvrier in *Comptes Rendus*, that we cannot decompose sulphate of copper by alternating currents. The absence of all electrolytic phenomena in this case is explained by supposing that the copper deposited on each electrode is immediately re-dissolved by the inverse current. This negative experiment is even presented as a proof of the equality of the two successive induced currents as far as their quantity of electricity is concerned. We have been enabled to justify this explanation by rendering the decomposition of sulphate of copper visible, just as we have done with acidulated water, though this novel experiment is both more complex than the former (*Comptes Rendus*, June 18, 1888,) and more difficult to carry out.

If we substitute in the platinum wire voltameter a strong solution of sulphate of copper for the acidulated water, currents of a mean intensity of 2½ ampères which previously produced a plentiful escape of detonating gas produce nothing in the sulphate except a considerable heating; but if we then reduce the dimensions of the electrodes to 0.1 millimetre in diameter and 20 millimetres in length (or about 6 square millimetres of surface), there appears at once an escape of gas and a deposit of copper.

The electrolysis succeeds equally well with copper electrodes of the same dimensions. As soon as the current passes we see arise a sheet of fine bubbles and a reddish brown cloud of pulverulent copper, and the electrodes themselves quickly take the aspect of spongy copper freshly reduced.

It seems, therefore, to follow from the whole of our experiments that in electrolysis by alternating currents it is always possible to reach a sort of equilibrium between the rate of decomposition of the electrolyte and the rate of recombination of its elements.

When once this equilibrum is reached there is no longer, or, at least, there no longer appears, an electrolysis properly so-called. But then all the circumstances which may make the former rate predominate over the latter will cause the products of the electrolysis to re-appear; and, on the contrary, all which tend to make the rate of decomposition predominate will make such products again disappear.

In the first rank of the conditions which accelerate the electrolysis, we must name the *density* of the current, that is, the ratio of its mean intensity to the surface of the electrodes. It is evident that if on the one hand, we increase the quantity of electricity which traverse the electrode, and on the other hand diminish the surface of the electrodes, we shall cause the rate of decomposition to predominate over the rate of re-combination and promote the appearance and the liberation of the products of electrolysis, as our experiments have verified in the electrolysis of acidulated water.

We conceive equally that the electrodes and the electrolyte may affect the rate of re-combination by their chemical affinities or their physical properties. The facility of electrolysis must, therefore, depend also on the nature of the electrodes and the electrolyte. This is what our comparative experiments have verified in the electrolyses of acidulated water and of sulphate of copper, both by platinum and copper electrodes.

We may furthur forsee that the greater or less rapidity of the alternations, all other things being equal, must play an important part in the appearance or disappearance of the electrolytic phenomena. For if we suppose that the succession of the two induced currents becomes so slow that the electrolytic products of the first current have disappeared from the electrode, whether by direct disengagement or by diffusing before the products of the inverse current have appeared there, no more re-combination will be possible; each of the alternating currents will behave successively in the voltameter like a continuous current of brief duration. We see, then, that all other conditions being equal, a retardation of the alternations must facilitate the appearance of electrolysis, whilst the acceleration of the alternations produces the contrary effect. This we have been able to verify by direct experiments.

The use of dynamos with a separate exciter has enabled us to vary the rapidity of the alternations without affecting the mean intensity, nor, consequently, the density of the currents. On the one hand, by raising the speed of the machine from 1,500 to 2,600 turns per minute, we could raise the number of alternations from 100 to 173 per second. On the other hand, by suitably modifying the intensity of the inducing magnetic field by means of the exciting current, we could keep the mean intensity of the induced currents constant. Under these conditions we have made the two following experiments:

1. The machine turning at its ordinary speed (2,000 turns per minute, corresponding to 133 alternations per second). We regulate the intensity of the currents so as to maintain the state of equilibrium, that is, to cause all liberation of gas in a voltameter with acidulated water to disappear. If at this moment we let the velocity sink to 1,500 turns, we see the gas reappear and freely liberated at the electrodes.

2. When the machine is revolving at its ordinary rate of 2,000 turns, we regulate the density of the current so as to give a distinct and regular escape of gas. If at that moment we raise the speed to 2,600 turns, all the escape at once disappears.

In either case we can annul the effect of this variation of speed by a suitable modification of the density. Thus in the first experiment we can cause the gas to disappear again by enlarging the surface of the electrodes, and in the second experiment they can be made to reappear by reducing this surface.

We see, then, that the rapidity of the alternations and the variations in the density of the currents affect the electrolysis in opposite directions, and that it may be manifested with currents of low density if the alternations are sufficiently slackened. This explains how, in 1837, De la Rive could easily decompose acidulated water by the alternating currents of the magneto-electric machines then recently invented. He succeeded in realizing the development of detonating gas on large platinum electrodes, having a surface of 8 square centimetres. His difficulty seems to have been to make the gases disappear, while ours was to make them appear. This difference results from the fact that the electro-motor employed by De la Rive gave at most 50 alternations per second, while our dynamos give 100 as a minimum.

From this experimental study of the circumstances which affect electrolysis by alternating currents, we may deduce, along with the numerical laws of these phenomena, the general rules which ought to direct the utilization of these currents for this kind of application.

ENGLISH NOTES.

LONDON, Aug. 15, 1888.

The Edison-Swan Case.

The action brought by the Edison-Swan Company against "Holland and others" was again mentioned in the Chancery Division of the High Court of Justice last week, in the form of an application on the part of the plaintiffs to have an inquiry made into the damages sustained by them, owing to the infringement of the Cheesbrough patent by the Anglo-American Brush Corporation. The judge ordered that this should be done and that the Brush Company were to deliver up to the Edison-Swan Company all lamps remaining in their possession, which had undergone the flashing process. The Brush Company will, therefore, virtually have to pay royalties to the Edison-Swan Company upon the whole of the "Victoria" lamps, which have been made and sold from the beginning; but the Court will probably refuse to fix the royalty at a very high figure.

The New Woodhouse & Rawson Lamp.

One result of the recent lamp litigation has been to bring Messrs. Woodhouse & Rawson once more into the field as manufacturers of incandescent lamps. They have devoted their enforced leisure in this department to the production of a totally new form of carbon, of which I have already spoken in a former letter in connection with microphone contacts. The peculiarity of this material is that it possesses a far higher specific resistance and also a higher specific gravity than any form of carbon hitherto employed for electrical purposes. Messrs. Woodhouse & Rawson have just brought out an incandescent lamp made of this description, especially intended for ship lighting. It is well known that the life of lamps used in this class of work is much below the average, owing to the continual vibration to which the filament is subjected. Most lamps burnt out aboard ship are found to have their filaments broken just at the point where the strain of the continual vibrations is the most severe. On board men-of-war, moreover, it is a common thing to find a large number of lamps destroyed every time the heavy guns are fired. In the new ship lamp the filament is only of about two-thirds of the total length of an Edison-Swan lamp of the same voltage and candle power, and its section instead of being circular is flat or ribbon-shaped, so that the vibrations are entirely confined to one plane. This seems likely to be an improvement of very considerable value.

The Electric Light at the Naval Manœuvres.

The electric light has been very prominent during the present naval manœuvres, and although accounts somewhat differ as to its actual value, there can be no doubt that it is one of the indispensable adjuncts to a modern man-of-war. Some complaints have been made that the lookout men are so dazzled by the beam that they are unable to keep as sharp a watch as is necessary in directions which are not at the moment illuminated. On the other hand, this dazzling effect was turned to a good use during the naval manœuvres of last year, when the gunners manning the guns in the Pembroke Dock forts were rendered almost blind every now and again by the attacking ships skillfully flashing the light full in their faces, and during the interval of darkness moving rapidly to another point. This year Admiral Tryon made clever use of the electric light in a manner which recalls a somewhat similar use made by the French in their attack on Sfax. Unable to approach the forts near enough to deliver an effective fire, the French Admiral placed his Hotchkiss quick-firing shell-guns on board his small boats, and as soon as it was dark sent them to attack the enemy at close quarters. He then threw the strongest possible light upon the forts, and the small boats moving ahead in the darkness just beyond the flashes of light, came in close to the forts and poured in a deadly fire. The defenders, completely bewildered, capitulated soon after daylight. As another instance of the extensive use of electricity aboard ship I may mention that the Cape mail steamer "Norham Castle," which has just been refitted with the electric light, has been provided with a submarine lamp, by means of which the hull and propeller can be easily examined.

Electric Traction on the London & Southwark Subway.

I am glad to be able to report that at a recent meeting of the City of London & Southwark Subway Company it was practically decided to adopt electric traction on the company's line. The Chairman, Mr. C. G. Mott, explained that, for various reasons, the Board were of opinion that the original idea of the Halliday cable was not practicable, and that having tried various experiments, the Board had come to the conclusion that electricity was the power which was likely to prove the most useful. At an extraordinary meeting, which then followed, a resolution was agreed to, with a few dissentients, enabling the Board to prosecute further experiments with electricity. A few details of this company's scheme may perhaps prove of interest to your readers. The Subway Company was formed for the purpose of giving better access to and from the city and the south of London. It was incorporated by Act of Parliament in 1884, and empowered to construct a double line of subway from King William street, in the city, to Stockwell, on the south side of the Thames. The act prohibited the use of steam locomotives, so that the directors were obliged to choose between cable traction, compressed air, or electricity. The total length of the line is rather more than three miles, and the total cost is estimated at about £750,000. The steepest gradient is about 1 in 30, but the line throughout the greater part of its length is practically level. The two tunnels for the "up" and "down" lines are absolutely separate and distinct between the termini. On leaving the city terminus the tunnels are side by side, but by the time the Thames is reached they are superimposed, and before the southern side is reached they are again side by side. Each of the tunnels is 10 feet in diameter, and is formed of rings of cast-iron segments bolted together through internal flanges. The average speed will be about 10 miles an hour, and it is intended at first to

run every two minutes trains capable of carrying 100 passengers. Owing to the absence of steam the question of ventilation will be a comparatively easy one, and the line will doubtless prove a welcome addition to the somewhat scanty means of access to the city from the densely populated and ever-growing districts beyond the Thames.

Mr. Hugh Watt, M. P.

The career of Mr. Hugh Watt, both as a politician and as an electrician, has met with an abrupt termination. Last week he was requested by his constituents to take the earliest opportunity of ceasing to represent them in Parliament, and a few days later it was announced that he had also resigned his position as Director and Manager of the Maxim-Weston Company, and that the Board had accepted his resignation. I do not want to kick a man who is down, but it is impossible to shut one's eyes to the fact that the prospects of the Maxim-Weston Company are vastly improved since they have been delivered from the incubus under which they have been so long struggling.

The Metropolitan Electric Supply Company.

I am sorry to say that the Metropolitan Electric Supply Company, who, as I recently informed you, had prepared a very extensive scheme for lighting the central parts of London, have been obliged to postpone their action until the next parliamentary session, as it was found impossible to carry through the necessary confirmation bill before the adjournment of Parliament, which has just taken place.

Cabling Extraordinary.

Last week the Eastern Telegraph Company performed what is in all probability the most remarkable feat in rapid cable telegraphy on record. A telegram from the Queen congratulating the Governor of Victoria upon the opening of the Melbourne Centenary Exhibition, and consisting of 13 words, was received in Melbourne sixteen minutes after reaching the London office.

Electric Launches.

The electric launch "Volta," which achieved distinction a couple of years ago by making a voyage from Dover to Calais and back again, has this week appeared once more upon the river, and has accomplished the trip from Milwall to Richmond and back several times with excellent results.

Magneto Call Bells.

It is a rather singular fact that the magneto call bells hitherto in use on the telephone lines of this country are all of American manufacture, or at any rate are manufactured by an American company, for I believe most of them come from the Western Electric Company's Works at Antwerp. An effort is now being made by the Telegraph Manufacturing Company, of Helsby, to obtain a share in the business. They have brought out a magneto call bell which is similar in general design to the American pattern, but is, it is said, better finished and introduces several substantial improvements in the mechanism. For instance, the shaft of the driving wheel passes through a slotted tube, through which it moves slightly forward when rotated, until the stud presses against a contact spring, which brings the armature coils in circuit. The advantage of this design is that the bearings of the wheel no longer form a part of the circuit, as in the old pattern.

THE ELECTRIC LIGHT.

Joliette, Can, is to have electric lighting.

Ashland, Va.—Mr. A. E. Cloud will put in an electric light plant.

Richmond, Va.—The Gallego Flour Mills will put in an electric light plant.

Clearfield, Pa.—The Harder Gun Works, at Clearfield, are to have a 30-light plant.

Aberdeen, Miss.—The Aberdeen Electric Light Company is to increase its engine capacity.

New Britain, Conn.—The Edison plant at New Britain is to be enlarged to meet the demand for light.

Niagara Falls, N. Y.—The Brush Electric Light and Power Company has just added to its arc light plant.

Griffin, Ga.—The Kincaid Manufacturing Company have bought electric light machinery for their mill.

Salinas, Cal.—The 30 arc light plant of the Salinas Gas and Water Company is to be in operation by Oct. 1.

Narragansett Pier, R. I.—The Narragansett Pier Electric Light Company is to extend its service to Wakefield and Peace Dale.

Charleston, S. C.—The Charleston Electric Light Company contemplates putting in a branch plant at the suburb of Sullivan's Island.

Sidney, O.—The Sidney Electric Light Company has been incorporated by H. W. Thompson and others with a capital stock of $15,000.

Winchester, Vt., is well pleased with the arc lights recently introduced there, and incandescents are now to be supplied for the stores.

Meridian, Miss.—Mr. E. J. O'Beirne has secured an electric light franchise and is negotiating for the erection of a Thomson-Houston plant.

Muskegon, Mich.—The Muskegon Electric Light Company has been incorporated by R. E. Bunker and others with a capital stock of $50,000.

Fort Worth, Tex.—The Marr Construction Company are now installing a 1,950 light plant of the Westinghouse alternating system at Fort Worth.

Macon, Ga.—The Macon Gas-Light and Water Company are to build a new and enlarged plant for arc and incandescent lighting, to be ready by Oct. 1.

Ware, Mass., is going in heavily for the electric light, having already nearly 400 incandescents and over 40 arcs in use. An increase of plant is probable at a very early date.

Grand Ledge, Mich.—The Common Council of Grand Ledge has voted to buy an 80 h. p. engine from the Lansing Iron and Engine Works, to operate its electric light plant.

Greensboro, N. C.—It is stated that an electric light plant is to be added to the works of the Greensboro Gas Company, bought recently by Baltimore parties. Mr. H. B. Peters is the manager.

Cherryfield, Me.—Over 125 lights have been subscribed for at Cherryfield, to be supplied from the plant in Campbell & Co.'s grist mill. Mr. W. M. Nash is also lighting his mill by electricity.

Marquette, Mich.—The Duluth, South Shore & Atlantic Railroad Company, Marquette, Mich., have recently increased their arc light plant by ordering a number of arc lights from the Brush Electric Company.

The Fitchburg, Mass., Steam Engine Company has issued a neat pamphlet specially devoted to electric light. It is pointed and pithy, and as a copy can be had free on application, it should have a wide circulation.

Gainesville, Tex.—The Electric Light and Power Company have contracted with the Westinghouse Electric Company for an incandescent plant of 1,300 lights. The Marr Company are to do the construction work and also furnish the steam power.

Richmond, Va.—The Virginia Electric Light & Power Company will erect an electric light plant at the grounds of the Virginia Agricultural and Mechanical Society. The capacity will be 150 arc and 500 incandescent lights. Power will be furnished for the electric railroad, previously reported.

Eau Claire, Wis.—The Eau Claire Brush Electric Company have recently ordered fifteen 2,000 c. p. arc lamps from the Brush Electric Company, Cleveland, Ohio. The Eau Claire Company have made large additions to their station during the past year, and are reported to be in a very flourishing condition.

Costello, Pa.—C. C. Sutherland, general agent of the Brush Electric Company for the western part of New York State, has recently sold to Alfred Costello & Co., for their tannery at Costello, Pa., an incandescent electric light plant complete, consisting of a 200-light dynamo with the full complement of lamps.

Little Rock, Ark.—The Little Rock (Ark.) Electric Light Company have closed a contract with the Westinghouse Electric Company for an incandescent plant of 1,300 lights, which is to be in operation in about thirty days under an agreement with the Marr Construction Company, of Pittsburgh, who make the installation.

Charlestown, Mass.—The Charlestown Gas Company have recently increased their electric light plant by the purchase of a number of double arc lamps from the Brush Electric Company, of Cleveland. They now have in use several Brush dynamos of 30-light capacity each, and several hundred 2,000 c. p. Brush arc lamps.

Harrison Safety Boilers.—Messrs. Cheney Brothers, the well-known silk manufacturers of South Manchester, Conn., are now putting in another battery of Harrison safety boilers, aggregating 480 h. p. This makes a total of 2,200 h. p. of these boilers purchased by the firm, and is their eighth order after 21 years' experience with them.

Binghamton, N. Y.—The Binghamton Gas and Electric Company, of Binghamton, N. Y., are increasing their electric light plant. They have ordered from the Brush Electric Company, Cleveland, O., one 65-arc light 2,000 c. p. dynamo and arc lamps. The company are now burning some 200 arc and 300 or 490 incandescence lights of the Brush system.

Milford, Mass.—The Electric Light Company's room at the station at Milford has been increased preparatory to the addition of a new 100 horse-power engine soon to be purchased. The two 60 horse-power engines now in use will eventually be displaced by two of 100 horse-power, the increase being rendered necessary to keep pace with the company's growing business.

Glenwood Springs, Colo.—The Glenwood Electric Light Company, of Glenwood Springs, have recently increased their electric light plant by purchasing a Brush dynamo, 65 light capacity, 2,000 c. p., with a full complement of 2,000 c. p. arc lamps. The company are now operating 125 arc lights and several hundred incandescent lights of the Brush system.

Rochester, N. Y.—The Brush Electric Light Company, of Rochester, N. Y., has recently ordered a large number of arc lamps from the Brush Electric Company, of Cleveland. This company, which is one of the best managed electric light companies in the country, uses the Brush system of lighting. It is now burning 1,150 arc lights and 1,000 incandescents.

Custom House, St. Louis, Mo.—The representatives of the United States Electric Lighting Company, which was recently awarded the contract for completing the lighting of the St. Louis Custom-House and Post-Office, left for Philadelphia this week, taking with them plans and specifications for the new plant, which they will set up in the building in a few weeks. It will cost $20,500.—*Age of Steel.*

Coshocton, O.—The Coshocton Light, Fuel and Power Company have a five-year contract with the village for 45 arc lights running every night till 1 o'clock, for $77.33 per annum per lamp. They have contracted with the Jenney Company, of Indianapolis, for a complete plant with a capacity of 75 lights, and the contract requires the plant to be running within 90 days. Mr. Houston Hay, of the firm of Houston Hay & Sons, manufacturers of fine axles, is president of the company.

Red Wing, Minn.—The Globe Electric Light and Power Company, of Minneapolis, have sold their Red Wing plant to local parties. The new company has organized as the Red Wing Electric Light and Power Company, with the following officers: B F. Hanscom, of Minneapolis, president; G. A. Carlson, vice-president; G. R. Sterling, general manager; S. D. Lauther, secretary, and E. L. Castle, superintendent and electrician, all being of Red Wing. The new concern starts with bright prospects, as the plant is in good shape and is doing an excellent and growing business.

New York City.—The Shultz Belting Company, of St. Louis, has just made and put into the plant of the East River Electric Company, New York City, one of the largest belts ever made in this country, and the largest ever made west of New York. It is 123 feet long, 58 inches wide, and weighs 1300 pounds. It is made of double leather, is to transmit 1000 horse-power, and takes the place of an oak-tanned belt. The company made the belt, delivered it in New York and had it transmitting power inside of six days. This speaks well of the fulled leather (rawhide) belting made by this company. The belt was cemented only, no pegs or rivets being used. Attendants at the National Electric Light Convention should visit the station.

Muncie, Ind.—We were attracted by the sound of machinery in a large building not far from the Kirby, and upon entering found two great furnaces burning natural gas and furnishing the power for two large engines—one of 80 h. p. and the other 50, propelling two large dynamo machines. This we learn was the works of the Muncie Heat, and Light Power Company, a plant that cost the company $50,000. They are operating 750 Edison incandescent lights, eighteen Brush arc lights and twelve Ball arc lights. This company owns three large gas wells that supply the fuel for running their machinery and the homes of many of the residents of the city. Natural gas for fuel has some very striking advantages, among which are the saving of labor in attending fires, the regularity of the heat supply and the cleanliness, there being no dust ashes, or cinders.—*Angola Herald.*

APPLICATIONS OF POWER.

Washington, D. C.—The Eckington and Soldiers' Home Railway Company have obtained a permit to build an electric road.

Wheeling, W. Va., was visited by a tremendous storm on Aug. 21, when the floods carried away a bridge over which the electric railway ran.

Lynchburg, Va.—The Lynchburg Street Railway Company will operate their road by electric motors. It is said that the plant has not yet been contracted for. Mr. S. Adams is president of the company.

Cleveland, O.—Another electric road is wanted in Cleveland, and the South Side Street Railway Company has applied to the Board of Councilmen for permission to build and operate a road by electricity. The residents along the route are all in favor of the road.

Washington, D. C.—In the U. S. Senate on Aug. 17, Mr. Edmunds' motion instructing the committee on the District of Columbia to report a resolution requiring the commissioners to revoke the permits already given for overhead electric motive wires was taken up, and after considerable discussion was agreed to.

Danville, Va.—The Danville Street Car Company have contracted with the Thomson-Houston Company for four cars, and are now equipping two miles of track to be operated by electricity within the next thirty days. An extension of the road is talked of but has not yet been decided upon. Mr. T. B. Fitzgerald is the president of the company.

Cleveland, O.—Ground has been broken at the junction of Cedar and Willson avenues for the power house for the East Cleveland Street Railway Company's electric service. Contracts require the building to be completed Sept. 16, and the boilers to ready Oct. 1. The company has been notified that some of the dynamos have been shipped already.

Des Moines, Ia.—A company has been formed in Des Moines' with a capital of $100,000, for the manufacture of the Wells electric motor for the purpose of building and operating electric motors and leasing the same. Jesse Wells, of Des Moines, is the patentee, and the incorporators of the company are R. N. Bayliss, Jesse O. Wells, Samuel Merrill, H. E. Teachout, Wm. M. Lamphere, Albert T. Hess and David H. Ogden. It is said to be probable that the Broad Gauge Electric Street Railway Company will take power from this company.

Davenport, Ia.—The Davenport *Tribune* gives an enthusiastic report of the going into operation there of the Sprague electric road of the Central Railway Company. The road is 5¾ miles long, with grades up to 7.30 per cent., eight switches, twelve curves and three railroad crossings. The cars were built by the Laclede Company, of St. Louis, and weigh with motors 3,600 lbs. They are 22 ft. long and have Edison lights and electric fareboxes. The overhead system is used. The same plant will supply power for a large number of stationary motors.

Cleveland, O.—The Brush Electric Company is very busy, and has orders and installations in hand for all parts of the country. Messrs. Brush and Pfannkuche finished last week their tests of the first 150 h. p. generator and 75 h. p. motor, which have now been forwarded to California. These machines are the first of some six or eight that the company are about to ship, and the tests have been beyond expectation, both generator and motor exceeding their rated capacity. The motor, which is one of the largest ever built, developed 90 h. p. during the test. The company are more than pleased with the results, and look forward to a very large business in that particular line.

PERSONALS.

Mr. W. Oswald, the agent of the Sprague Company at New Orleans, has put in 60 Sprague motors during the past year, from ½ h. p. to 10 h. p., and aggregating 200 h. p.

Mr. S. D. Brewer, general manager of the Hussey Reheater and Steam Plant Improvement Company, has been looking over the ground at Carthage, N. Y., with a view to locating the factory of the concern there. Carthage seems anxious to secure this new industry, and will probably offer inducements.

Mr. David Brooks writes to the Philadelphia papers on lightning rods, in which he calls special attention to the desirability of perfect ground connections. He also says that no one has been killed in Philadelphia in 40 years in the built up portions of the city, and the reason is that the gas pipes have fulfilled the requisites of a lightning rod perfectly constructed.

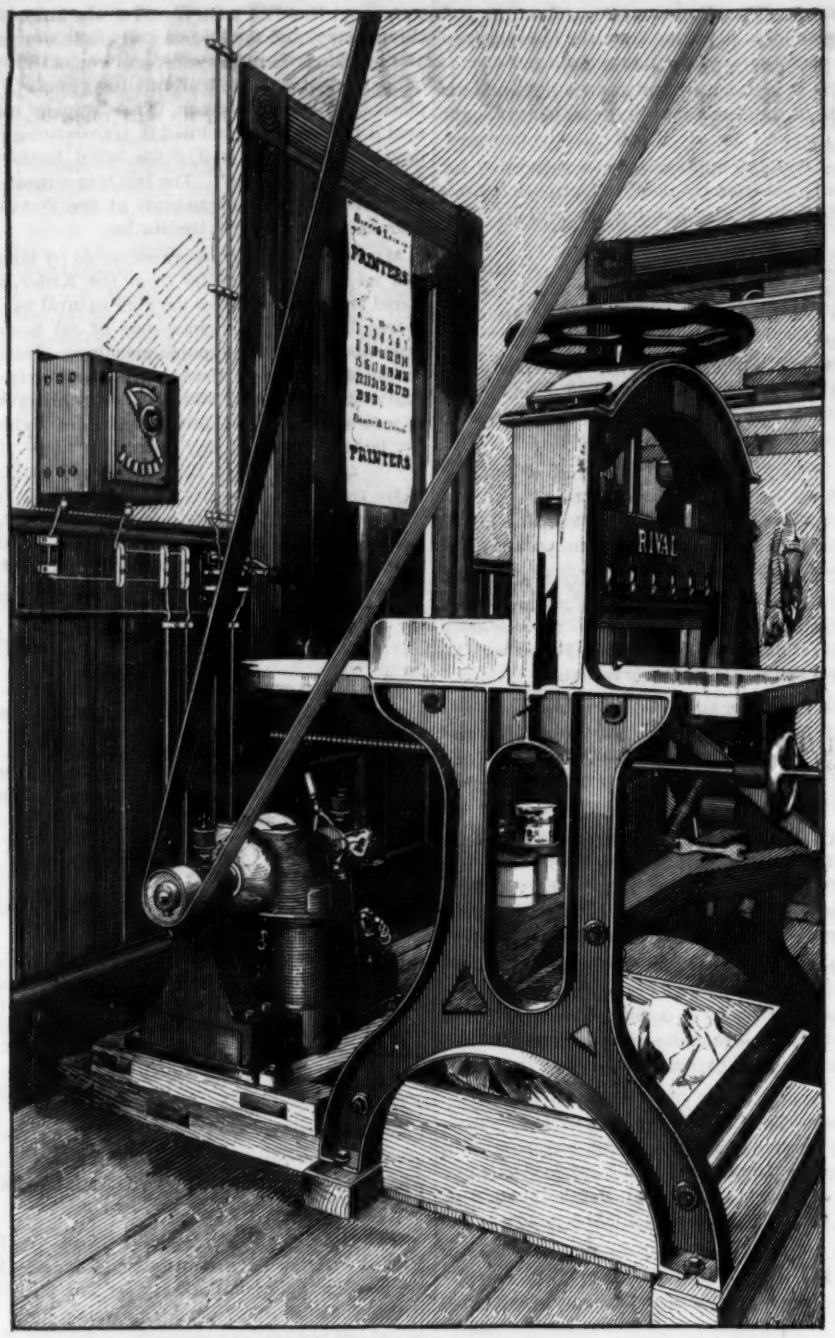


FIG. 1.—THOMSON-HOUSTON MOTOR, IN PRINTING OFFICE, SALEM, MASS.

Motors in Printing Offices.

One of the many purposes to which the electric motor can be applied is illustrated in the two accompanying cuts. Fig. 2 shows the Thomson-Houston motor operating the printing press in the office of the *Daily News*, Salem, Mass.

The press is a type-revolving, double cylinder, Hoe perfecting, and one of the largest in New England outside of Boston. It was formerly operated by a 10 h. p. engine which showed a perceptible decrease in speed whenever the press was put on, and was unable to operate the paper dampening machine at the same time, which additional work the engine was supposed to be capable of doing. The superior advantages of the Thomson-Houston electric motor over a small isolated steam plant led to its adoption, and both the machines are now operated by a 10 h. p. motor, and without appreciable change in speed between full and light loads. The editions of the *News* are now run off in a much shorter time than formerly, and heat and dust and the noise of the engine, which was decidedly objectionable to the other occupants of the building, are entirely done away with.

Fig. 1 shows the printing establishment of Barry & Lufkin, Salem, Mass., and illustrates one of the peculiar advantages of the electric motor; that of placing it as in the present instance under the paper cutter, or in some space which would otherwise be unoccupied. The motor used here is of 1½ h. p.

Both of these motors were installed by the company's Eastern agent, Mr. H. C. Spaulding, and have given eminent satisfaction in every way to the users.

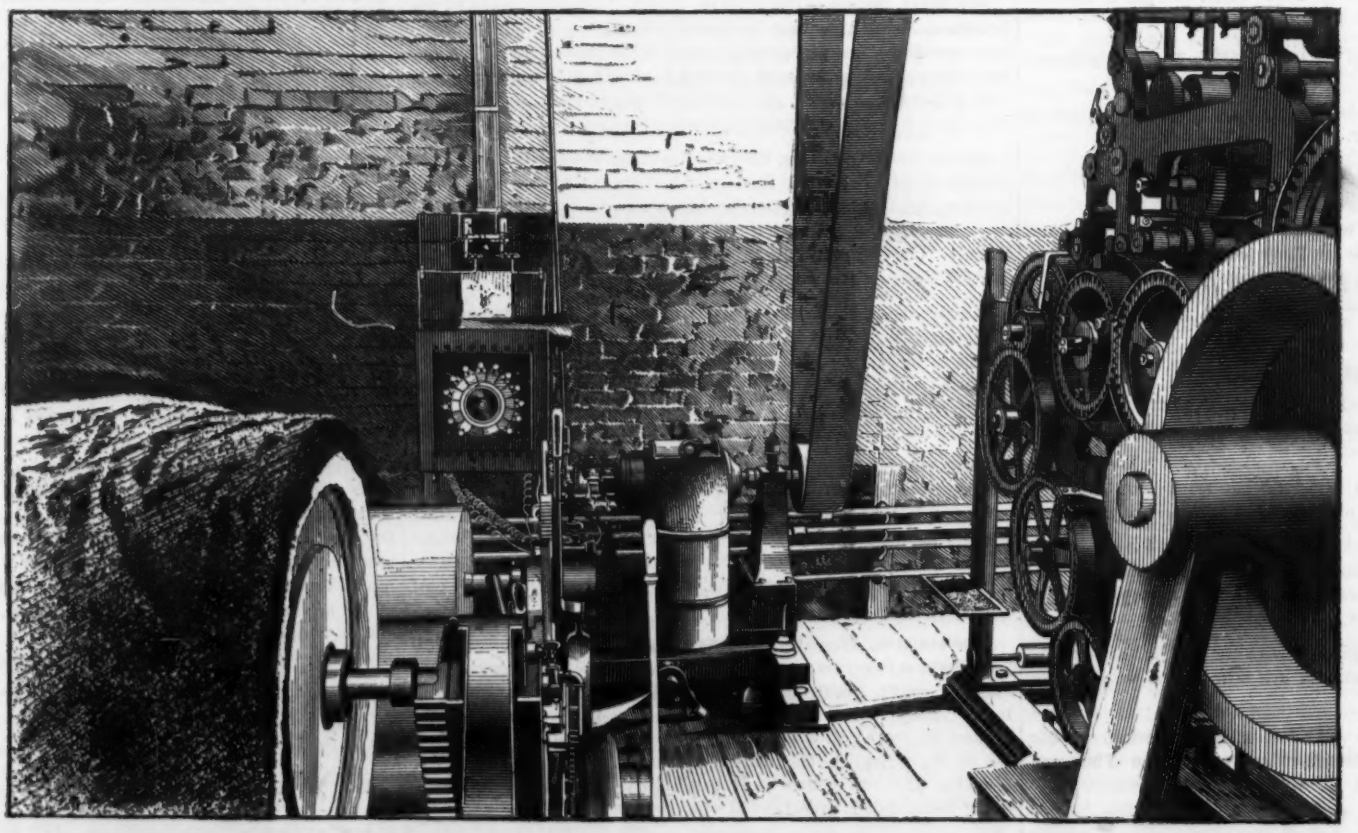


FIG. 2.—THOMSON-HOUSTON MOTOR, WITH PRINTING PRESS, SALEM, MASS.

Local Authorities and Electric Lighting.

With regard to the present situation in England, the London *Electrician* says:

The passing of the Electric Lighting Amendment Act this session has already resulted not only in the formation of several new companies with large aims for the supply of electricity within the metropolitan area, but in the revival of numerous demands for electric lighting in provincial towns where the original act of 1882 had effectually extinguished such schemes. We hear rumors of fresh companies being started, of applications for licenses and provisional orders being projected, and, moreover, of local authorities being desirous of undertaking the business on their own account. The large experience which has been gained and the confidence inspired in the interval between 1882 and the present time certainly justifies this activity; and it does not surprise us that the attitude of local authorities, which was then extremely shy, or covertly hostile, is now almost uniformly favorable. The first question they will have to decide will be whether they shall permit the right of public lighting to pass out of their hands into those of private companies; and, on the other hand, one of the questions which existing or projected companies must consider is, whether they will approach the local authorities as undertakers—to quote the wording of the Act—or as contractors?

Measuring the Strength of a Field.

The lack of a simple and expeditious means of measuring the strength of the magnetic field has long been felt. Lippmann's method (depending on the alteration in the height of a balanced column of mercury placed in the field to be measured, and through which a current is passed), although remarkably ingenious, is open to serious objection. The employment of glass tubing is of itself almost fatal to its usefulness in practical measurements of dynamo machines. At last, however, it would seem that a method is available which promises to fulfill every reasonable condition, and for which we are inclined to anticipate a considerable field of usefulness. It has long been known that the electrical resistance of bismuth is increased when it is placed in a magnetic field, and Leduc proposed to employ this property to measure, empirically, the strength of the field. But the increase of resistance observed in ordinary bismuth is not so marked as to render the phenomenon very readily available. Now, however, says the London *Electrician*, Drs. Lenard and Howard have succeeded in preparing flat spirals of bismuth wire in which the resistance increases from about 10 to about 20 ohms in a field of 17,000 C. G. S. units. An ordinary Wheatstone bridge measurement and a table of reference will therefore enable the dynamo manufacturer to measure any field into which a thin flat spiral can be inserted.

Telegraphy with Superposed Pulsatory and Undulatory Current Signals.—II.

BY WILLIAM MAVER, JR.

Probably the next inventor after Varley, in the line of simultaneous telegraph and pulsatory current telegraphy, was Edison.

In 1878 he devised an arrangement consisting of a means for producing single pulsatory currents to be superposed on a telegraph circuit.

The means consisted of a reversing key or pole changer *PC*, Fig. 7, which reversed the position of an electro-magnet or an auxiliary battery in the main line. The receiving instrument for these momentary currents was an ordinary telephone. It will be understood that the action of reversing the position of the electro-magnet or an auxiliary battery in the line causes an abrupt momentary slight increase or decrease of the telegraph current, producing signals which will be felt in the telephone without affecting the regular telegraph signals. It is obvious, however, that some alteration of the Morse alphabet would be required were this method of transmitting and receiving the pulsatory current adopted, inasmuch as a transmitted dot and dash would produce a signal of nearly equal duration in the ordinary telephone.

From the language of the specifications of the patent covering this device it would seem that Edison recognized the likelihood of interference in the telephone due to the abrupt make and break of the telegraph currents. To avoid this interference the patent shows an arrangement of the telegraph key *K*, Fig. 7, in which a resistance *R* is placed between its front and back contacts, so that when the key is closed the resistance is short circuited, and when the key is opened the resistance is thrown into the line, thereby strengthening and weakening the current to such an extent that the telegraph relays are operated. The inventor seems to have expected that this device would render the telegraph currents gradual in their rise and fall, for he states that owing to the form of the wave thus produced, the telegraph currents will not be felt in the telephone. Had this idea been carried into practice it doubtless would have been discovered that the plain resistance *R* would be insufficient for that purpose.

This invention was never, I believe, put into practice; but in the Edison phonoplex, to be described later, will be noticed a modification and improvement of the arrangement shown in Fig. 7.

Elisha Gray's well-known harmonic telegraph system may also be classed as a simultaneous telegraph and pulsatory current system, since regular Morse currents are transmitted in addition to the pulsatory currents of the harmonic system.

There is this difference, however, between this combination of pulsatory and telegraph currents and other kindred systems, namely, the telegraph currents are, as it were, superposed upon the pulsatory currents.

In this system also, the pulsatory currents are of much greater strength than in those systems in which the ordinary tuning fork and induction coil are employed, which is mainly due to the method employed to produce the pulsatory currents in the harmonic system; that is, by direct make and break of the battery in the main line, as shown in Fig. 8, which figure illustrates the sending and receiving stations A and *B* of the system in question.

At station *A*, F^1, F^2, F^3, F^4 are reeds attuned to different notes or rates of vibration. These reeds are kept in vibration in the usual manner, that is, by electro-magnets, not shown in the diagram. T^1, T^2, T^3, T^4 are double transmitters, the upper tongues, t^1, t^2, t^3, t^4, of which are insulated from the levers; the lower tongues are metallically connected to the levers.

At station *B*, f^1, f^2, f^3, f^4 are receiving reeds, accurately attuned to respond to vibrations set up by their corresponding transmitting reeds F^1, F^2, F^3, F^4. It will be seen that when the double transmitters are open, as at T^1, T^2, reeds F^1, F^2 are permitted to send out electrical vibrations, the result of makes and breaks of the batteries B^1, B^2, which those reeds respectively control. When closed, as at T^3, T^4, the contact is broken at p^3, p^4, and, consequently, the reeds F^3, F^4 do not send out electrical vibrations, although continuing to vibrate as before; and in this assumed position of the transmitter the corresponding receiving reeds f^1, f^2 are vibrating, and f^3, f^4 are at rest. As the double transmitters are furnished with local circuits and keys, as shown, and the receiving reeds with local circuits and sounders, not shown, signals may be simultaneously transmitted and received by all of the reeds.

It will be noticed that the batteries B^1, B^2, B^3, B^4 are divided or tapped at a certain point. It may be seen also that when a transmitter is closed, as at T^3, T^4, the larger portion of each battery is open at the lever of the transmitter, and that only the smaller portion is in the main circuit.

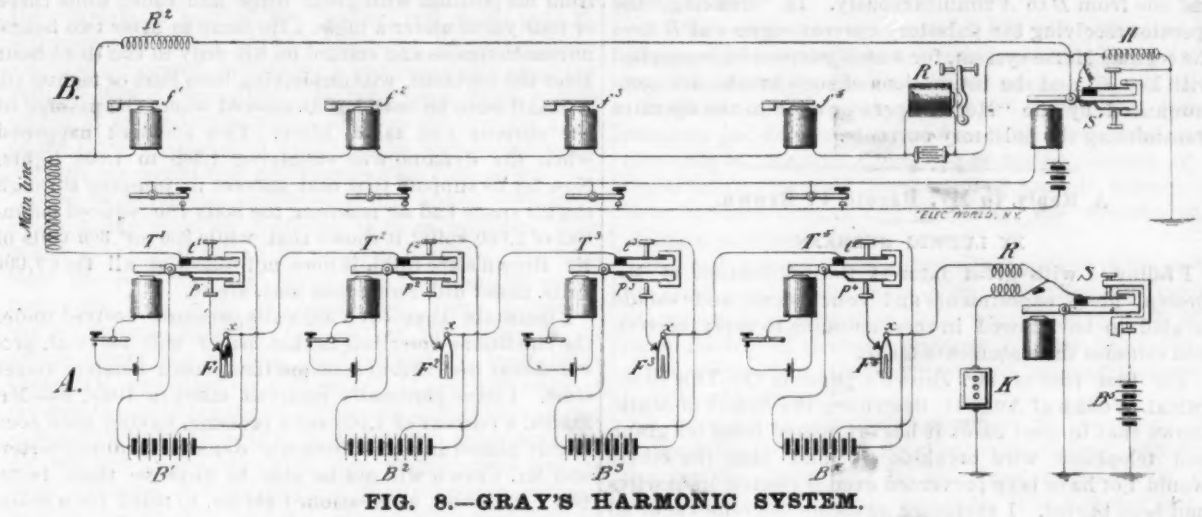


FIG. 8.—GRAY'S HARMONIC SYSTEM.

This arrangement of the batteries was rendered necessary owing to the great reduction of the current strength caused by the vibration of the transmitting reeds. This decrease in the strength amounted to about 60 per cent. For instance, if 40 cells maintained a maximum strength on the line when a transmitting reed is at rest, 100 cells would be required when it is in operation.

The telegraph, or Morse, portion of this system is composed of the differentially wound relay *R*, the single transmitter *S*, and battery B^5 and rheostat *K*, at station *A*, and double transmitter S^1, relay R^1 and resistance *H*, at station *B*.

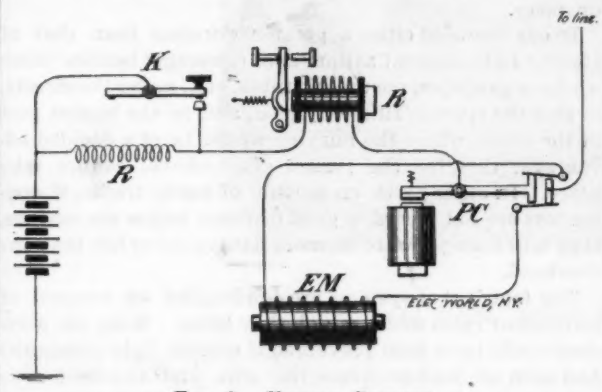


FIG. 7.—EDISON SYSTEM.

The transmitter *S* at *A*, when closed, places the additional battery B^5 to the line and thereby operates the relay R^1 at distant station *B*. Relays *R* and R^1 are shunted by condensers to permit the free passage of the vibratory currents. The double transmitter S^1 at *B* operates the differential relay *R* at *A* by throwing in and out of the circuit the resistance *H*. This latter transmitter is only used to "break" with, and to permit this, each receiving operator has a key controlling it, as shown. As it was found desirable to preserve a practically uniform current in the receiving relays of the harmonic system, an adjustable resistance R^2 is inserted in a wire leading from the lever of the transmitter S^1 to a point on the line outside of relay f^1, as in the figure, which resistance is thrown into the circuit simultaneously with the throwing out of the resistance *H*. This diverts from the relays as much of the increased current due to the removal of the resistance *H* as may be required to effect the desired result. At the same time, however, the removal of the resistance *H* disturbs the line balance at *A* and, as just said, operates the relay *R*.

In order that the Morse relays may not be affected by the vibratory currents, the springs of those relays are adjusted to hold the armature open over the maximum pulsatory current strength, and thus are only responsive to the additional battery B^5 or to the variation in the balance of the line caused by inserting or removing the resistance *H*.

No graduators are used in this system, and apparently are not essential, inasmuch as the reed armatures of the receivers being exactly attuned to the note of the corresponding transmitting reed, are not readily affected by pulsations that are not in unison with their rates of vibration. Furthermore, the large number of electro-magnets in the circuit must tend measurably to graduate the telegraph currents. It will be noticed that six messages may be simultaneously transmitted on a wire thus equipped, namely, five messages in one direction and one in the opposite direction.

Great expectations were at one time had of this system, and it was in practical operation on several circuits radiating from New York City. Its extensive use, however, appears to have been limited, not only by the expert care required in its adjustment, but also by the marked inductive effects of its pulsatory currents on parallel wires, which render it difficult to operate, to any great distance, more than one circuit equipped with this system, on one line of poles, and even on short circuits some difficulty has been experienced in working the system on more than one parallel wire. The large amount of battery requisite in its operation was also an objectionable feature, from an economical standpoint, when chemical batteries were used.

The majority, if not all, of the circuits on which this system was operated were abandoned some time ago, the quadruplex system now being used thereon.

It may be said in this relation that herein has been found, hitherto, an important advantage in favor of the quadruplex system over systems that employ rapid pulsatory currents of high E. M. F., namely, that the number of such quadruplex circuits possible to be worked on parallel wires, without recourse to the use of metallic circuits, cross connection or like means to prevent the effects of induction, has been only limited by the number of *available* wires on the poles.

The Edison "Phonoplex" is perhaps the most recently introduced example of simultaneous telegraph and pulsatory current systems. It differs from the arrangement already described, and shown in Fig. 7, in the method of producing and varying the pulsatory current and in the construction of and attachments to the telephone.

This system also differs from the Varley device, in that it does not use a continuous tone or "buzz." A theoretical diagram of the phonoplex connections is given in Fig. 9. In this figure *T* is a telephone of peculiar construction. It is ordinarily termed the "phone." *E* is a "magnetic coil," employed to set up pulsatory currents in the line. This it does, when the circuit, including the battery *B*, is opened and closed by the key *K*. These pulsatory currents, which are regulated by a transmitter T^v, operate in a manner to produce dots and dashes, by sound, in the distant "phone."

K is a Morse key, which, besides opening and closing the phonoplex battery *B* also operates the transmitter T^v. This transmitter is equipped with several extra levers, namely *L*, *L'* and *l*, and the contact *P*. When T^v is closed the lever *l* and contact point *P* complete the circuit formed by the wires 1 and 2, which shunts the phone. When the transmitter is open the points *P* and *l* are separated, thus leaving the phone in the main circuit ready to be operated by the distant phonoplex battery. This shunt circuit is provided in order that the currents from the "home" magnetic coil *E* may not operate the phone, for, since these currents are at their maximum height at this point, they would produce a disagreeably loud tone in the phone, and besides would more or less interfere with the prompt reception of breaks from the distant station.

When the transmitter T^v is open, the phonoplex circuit passes to the electro-magnet *E*, via the lever *L'*; when closed, via the lever *L* and through the resistance *r*. The object of using this resistance is to weaken the pulsatory current somewhat, so that there will be a difference in the strength of currents which produce the movements of the diaphragm of the receiving phone, sufficient to distinguish the "front" from the "back" stroke.

It is needful that some means be provided to increase the sound in the phone. This is accomplished by suspending lightly on the diaphragm of the phone a small split metal ring, which, when set in motion by the movements

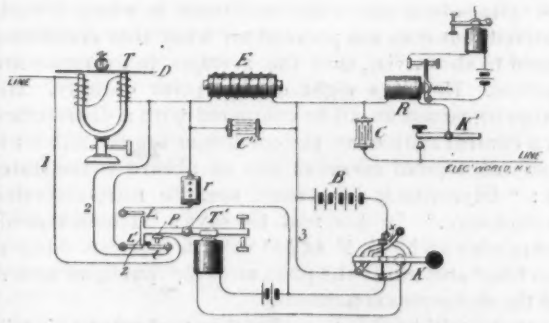


FIG. 9.—EDISON PHONOPLEX.

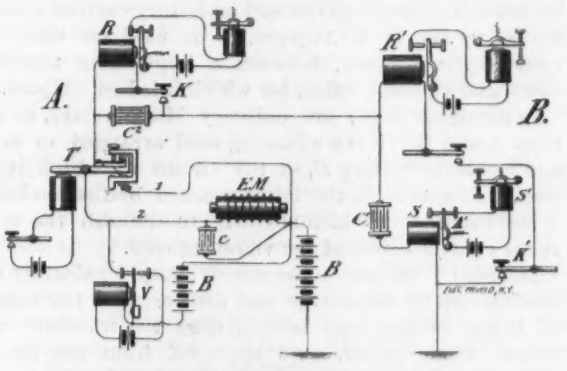


FIG. 10.—ATHEARN SYSTEM.

of the diaphragm, is thrown against its set nuts and thus greatly augments the sound.

When the key K is not in use, the lever x opens the battery B, and at the same time completes the phonoplex circuit via wire 3.

The Morse relay R and key K' are shown to the right of the figure. Condenser C permits the passage of pulsatory current signals in either position of key K'. Condenser C', which shunts the magnetic coil, is employed chiefly to prevent sparks at the points Z Z'.

Fig. 9 is supposed to represent an intermediate station, the main line passing through the office without going to earth.

The telephone receiver T is rendered more or less sensitive by means of a rack and pinion gearing, which allows the horseshoe magnet of the phone to be moved to or from the diaphragm D.

The "phone" T, as compared with the ordinary speaking telephone, is not a sensitive instrument, therefore the actuating battery must be correspondingly powerful. In fact, it may be said that the pulsatory currents are regulated to a point not much below what will affect the Morse relay of the telegraph circuit, and the receiver is rendered just sensitive enough to respond to those currents. By these means the telephone receiver is not readily affected by the ordinary induction, from neighboring wires nor by the telegraph battery. No special apparatus is used to graduate the telegraph currents. The condenser C and the magnet coils may be said to act incidentally in that capacity to a small extent.

This system of superposed currents is now in operation on many circuits throughout the United States and Canada, chiefly on railroad lines. It is workable on telegraph circuits of about 100 miles. When, however, the parallel circuits are operated with very heavy currents the distance to which the system will work may be considerably reduced.

The cause of this is doubtless that the induced currents from parallel wires weakens or strengthens the pulsatory current according as the inductive effects assist or diminish that current. An assisting induced current would, of course, only tend to increase the strength of the pulsatory signal, but the opposing or neutralizing inductive effect would necessitate increasing the sensitiveness of the phonoplex receiver or augmenting the strength of the pulsatory battery. In rendering the receiver more sensitive it becomes still more susceptible to a lower grade of induction from parallel wires as well as to the makes and breaks of the telegraph current, while by augmenting the pulsatory battery the danger of interfering with the Morse receiving apparatus is encountered. From which it may be gathered that the "happy medium" confines the system within certain limits as regards the distance to which it can be successfully operated.

It would doubtless be possible to somewhat increase the distance to which this system could be operated by adding to the strength of the pulsatory battery and also to the "telegraph" battery. But it is not always convenient or desirable to increase those batteries, as it would perhaps entail increasing the battery on every parallel line.

I have known of a phonoplex circuit to work for six hours over a wire that was entangled about midway of the circuit with nine other wires, when not another wire of the lot could be made available for regular telegraph work, the pulsatory current having "jumped" the crosses.

In Fig. 10 is illustrated another modification of the Varley simultaneous telegraph and pulsatory current system, devised by Mr. W. E Athearn, to be used on short circuits, as, for instance, between a large main telegraph office and a branch office, for which it is best adapted.

In the figure R R', are ordinary Morse relays, at stations A and B. V is a vibrating reed arranged to make and break the battery B, in the circuit of which is the electro-magnet E M, the latter shunted by the condenser c, the function of which is chiefly to diminish the spark at the contact points of the vibrating reed.

The reed V vibrates continuously, but the pulsatory currents set up by the charge and discharge of the magnet E M are broken into intervals by the transmitter T, which, when closed, cuts them off from the line, or when open gives them egress thereto. In the present position of the transmitter, it being open in the figure, the pulsatory currents may enter the main line.

At station B, S is a short core relay, more sensitive than the telegraph relay, and responsive to the pulsatory currents originated by the reed V. The local contact point of relay S is placed on the backstop as shown. The condenser C' by its charge and discharge, operates that relay and also separates it from the main line, so that when the pulsatory currents are not "flowing," the armature A' rests on its back contact, and its local circuit is closed. While pulsatory currents are being transmitted over the wire, the armature of the relay S is kept in rapid vibration between its front and back stops, and the local sounder S' is open. Thus the usual dots and dashes are recorded by the sounder, although each dot and dash may have been made up of a large number of rapid vibrations of the armature.

In either position of transmitter T the main line battery B' has access to the line by wires 1 or 2. The relay R is shunted with a condenser C^2 so that whether the key K is open or closed the pulsatory currents may reach the line, a condenser, as already said, being no bar to such currents. More correctly, perhaps, it is a repeater of them. It will be observed that there is no pulsatory current transmitting apparatus at station B, and no main line battery, and, consequently, no vibrating relay at station A. These could be supplied if desired, but the intention in devising this arrangement was to avoid complications of apparatus at the distant station or branch office, where, as a rule, the operators have not the time or are not sufficiently expert to give such apparatus proper attention. This arrangement, it will be noticed, provides greater facilities than the duplex system, inasmuch as it admits of sending two messages from A to B or one message from A to B and one from B to A simultaneously. In "breaking," the operator receiving the pulsatory current signals at B uses the regular Morse system, for which purpose he is supplied with key K', and the intimations of such breaks are communicated by the "Morse" operator at A to the operator transmitting the pulsatory currents.

A Reply to Mr. Harold P. Brown.

BY LUDWIG GUTMANN.

I followed with great interest the publication of Mr. Brown's ideas, experiments and conclusions, and should be glad to be allowed in these columns to reply, correct, and criticise the statements made.

The first part of Mr. Brown's paper in the THE ELECTRICAL WORLD of Aug. 11, describing the causes of death, shows that in most cases it has originated from telegraph and telephone wire break-downs, and that the others would not have been prevented even if electric light wires had been buried. I therefore advocate the removal of all telegraph and telephone wires from the poles, because their tensile strength, as experience shows, is too small to resist the elements. Not so the electric light wires, which ought to maintain their present position for the simple reason that the measures to put them underground cannot be carried out, or only to a limited extent, in large towns for which these rules have been originated. In small towns there is no difficulty in placing the conductors underground, but they are not in the way if carried on poles.

In our crowded cities a greater question than that of electric light is canalization and sewerage; besides these we have gas-pipes, pneumatic tubes, etc., under the streets, so that the space is fully occupied, and in the busiest part of the cities, where the burying would be of a decided advantage, this, for the reason given above, cannot take place. In other parts, on account of heavy traffic, if conductors are not buried a good distance below the surface, they will soon prove to be more dangerous to life than the overhead.

The fact is that systems are condemned on account of imprudent rules under which they labor. Many an accident could have been prevented if electric light companies had been allowed to choose the wire and not been compelled to use the "undertakers'" wire. If a mistake is possible it is sure to be made; this I say with reference to the new rule of the Board of Electrical Control in demanding the converters to be placed in the streets on poles. This is, to my knowledge, the only possible way which can cause the primary current to get into the secondary circuit in spite of all precautions. I shall return to this point later on. A man would be considered to be insane if he would expose a dynamo to wind and weather; but a converter is supposed to stand that.

Before going into any details, I wish to state that Mr. Brown's experiment clearly shows that a current at 200 or 300 volts is fatal under the conditions in which it is administered, but does not prove at all what that gentleman intended to show, viz., that the systems in operation are dangerous. He loses sight of this point entirely. His experiment cannot at all be compared with a distribution from a central station, as the conditions are too different. This so-called proof seems to me as absurd as the statement: "Glycerine is dangerous, because nitro-glycerine is an explosive." In his zeal he says: "I hold that all currents with an E. M. F. of 500 volts or more are dangerous to life," and wants the press and the public to understand the dangerous conditions.

Before he will be able to make this understood, it will be necessary for Mr. Brown to go to a central station to see and study the conditions under which the system works in order first to get an insight of it himself.

With regard to the statements of converter systems in England and in Germany they are both incorrect. In the Grosvenor Gallery, London, some four years ago, Gaulard and Gibbs converters (now replaced by those of Ferranti) of a pressure of 2,500 volts have been used, of the well-known disc type. The conductors are exposed and not encased in iron as the practice is now. They were then, and are now, placed in private houses, and locked in special wooden boxes allowing of ventilation. Several other systems are at work in various parts of Europe. Some three years ago I was sent by Messrs. Gaulard and Gibbs to Aschersleben (Germany) to assist in the erection of a plant. It was put up in a salt mine, and consisted of 2,000 incandescent and 40 arc lamps. The two dynamos, each capable of supplying 2,400 lights, worked with a pressure of 2,500 volts. The wiring was carried out by men in the employ of Messrs. Siemens and Halske, of Berlin, which firm also supplied the two dynamos and their well-insulated cables and conductors. On account of dampness and the salt crystals which were to be found everywhere, high insulation throughout the whole plant was necessary. Special precautions to insulate the dynamos were taken. The converters were all placed inside the offices and works. The station is luxuriously fitted out and spacious.

One accident I remember took place. The young man who was going to have charge of the dynamos and circuits stood near a dynamo, when one of the workmen called him. While his head was turned both his hands accidently came too near the two brushes; he was thrown from his position with great force and rolled some three or four yards under a table. He came to after two hours' unconsciousness and started on his duty in the third hour after the accident, without having been hurt or feeling ill. A small burn on both hands showed where the passage of the current had taken place. This accident happened when the dynamo was supplying 1,600 to 1,800 lights. Now let us suppose that that current in jumping through the air space had on reaching the body the reduced potential of 2,000 volts; it shows that while 200 or 300 volts of Mr. Brown's are fatal, it does not follow at all that 1,000 volts, under different conditions, are so.

I maintain that even 200 volts pressure received under the conditions described in that paper will be fatal, provided that the current is closed for a proportionately longer time. I have personally received many a time, like Mr. Smith, a current of 1,000 volts pressure, having been accidently placed in series between dynamo and converter, and Mr. Brown will not be able to disprove these facts. But I wish him, as mentioned before, to think for a moment that the conditions are too different to be comparable. The question has to be changed now to, "*Under what conditions are alternating currents fatal?*" I shall endeavor to treat this point later on.

The experiment which proved fatal I am unable to successfully criticise, as neither the particulars of construction of that apparatus, which he termed "converter" (because it contained an iron core and two independent wires), were given, nor how the dog was connected to the circuit, nor where the voltmeter readings were taken; besides, there was but a single converter in circuit. I wish to point out here that that converter can produce in its secondary coil (provided that both wires are of the same size) a pressure of not less than 18,000 volts, while converters in practical use have only a tension of 50 or 100 volts.

The primary current in the main wires capable of doing work equal to 80 or 100 horse-power is, of course, dangerous, but if prevented from reaching the secondary circuits will immediately make the system safe. Moreover, these 80 or 100 horse-power are *not* everywhere in the circuit, each consumer receiving in his house but one, two, perhaps five or ten horse-power.

Mr. Brown speaks of the pressure *only* and forgets altogether that to kill *work* must be expended, and that, therefore, the pressure alone is of no use; *the current is here of the same, if not of greater, importance.* He thinks that only a very small fraction of an ampère is sufficient to kill, but there he is slightly mistaken. The current, I think, will be measureable with a sensitive Siemens electro-dynamometer placed in series with the body. A proof for my statement that pressure with a small current will not injure, can be obtained by taking a static charge from a belt of a large engine, in which case the current will often jump a distance of 2½ feet and more. According to Mr. Brown this current, because it can be taken without any inconvenience, would have only about 50 or 60 volts pressure, but it can be proved that this current *must* have a pressure of some 20,000 to 30,000 volts. It has been stated that alternating currents are twice as hard to endure; it would therefore follow that the same current spoken of above, if alternating, could be taken with the same ease if flowing with a pressure of 10,000 to 15,000 volts.

The particulars of the Paris accident mentioned are not given; I suppose that the system in use was the Jablochkoff, and ground from line was effected, causing a powerful current to go to earth. Whether the voltage was less than that used at present is a question which can only be answered when we know the full particulars. I hesitate to believe the latter statement from a gentleman who jumps too quickly at conclusions, as his paper only shows too evidently.

The accident to Mr. W. L. Wright is of interest, and it would be desirable to know where the converters were placed, by whom made, where the accident happened and what were the conditions of the atmosphere at that time.

Mr. Brown need not pose as a marytr or a tribune of the people; the necessary precautions have always been taken and are constantly improving, provided that their application will not be objected to by the Board of Electrical Control, which body, for the safety of the general public, ought to consist of our leading electricians or such gentlemen who have shown by work or by their utterances that they have considerable experience. An inexperienced Board is equal to bad precautions, because people unacquainted with the action and behavior of apparatus can hardly set up rules for precaution, as they do not know where to look out for danger. When superintending the Utica plant (Slattery system), for the New York

Electric Construction Company, I placed the converters, of course, in the houses. When the work was finished an officer of the Board of Electrical Control came and ordered all the converters, "according to the rules," out in the street.

Let us now consider the difference. If a converter is placed inside a house, in the hall like a gas meter, or locked up in a wooden box, nobody will be hurt by it. It is kept dry in spite of air circulation that can, or ought to, take place, and should this converter get faulty the primary fuses will fully protect it and cut it out the moment the primary current would reach the secondary circuit. The reason is, that as soon as a ground occurs in the converter a part of the primary coil is cut out; the self-induction of the coil and, therefore, its virtual resistance, is decreased, permitting a comparatively large current to flow. Depending on this ground such a state might be equivalent to a dead cross on the line, and a fuse of ten times the size used would not be able to carry that current but would fuse and burst with a loud noise.

Now let us put the converter in the street. We try to prevent dampness by inclosing it in an iron box, from which we exclude the air as much as possible. For some time the converter will work well, the heat developed inside the box will, in expanding, force a part of the air surrounding the coil out of the casing at the points where the primary and secondary have to go through it, and other air will enter. If the difference in temperature between the converter and that of the external atmosphere is great, as it is on damp and cold days, the air, assisted by the converter, soon finds its way into the case, covering and depositing a film of steam or dampness on the two coils, and the primary has a bridge to the secondary. Now there follows a short circuit, a spark, and the fuses melt. Dampness takes the place of the thin tinfoil and the fuse is replaced by a damp conducting surface, allowing the primary to enter the secondary circuit. Such action can of course be avoided if converters are not considered as mysteries, but put on the same level with gas meters, which are just as dangerous, even if we *can* smell the escape of gas. How many people have been killed and how much property has been destroyed by coming too close to the gas meter with a light when looking for a leak!

In spite of the precautions already taken, Mr. Slattery, in this country, and Mr. Kent, in England, proposed, independently of each other, and at about the same time, to interpose between the primary and secondary coils a foil of copper, which has to be connected to earth. This, of course, would protect the secondary circuit, provided the converters were not placed in the street If then a ground would take place, the consumer would find that he could not light his lamps, and that would show there is something wrong without endangering life or property.

Alternating converter systems are perfectly safe with a pressure of 800 volts and more. Hitherto the highest pressure adopted has been 3,000 volts, on account of the difficulties experienced in insulating the conductors.

That system is the safest in which the pressure of primary and that of secondary has the greatest difference. The reason is obvious. Suppose I use a primary pressure of 2,000 volts in a converter supplying 80 lights each at 50 volts and 1 ampère. The primary current would be 2 ampères while that in the secondary is 80 ampères. Our primary fuse is a two ampère fuse, which, I hope, will not stand at a short circuit 30, 50 or 80 ampères under a pressure of 2,000 volts.

Now let us adopt, but only for this example, Mr. Brown's "Safe System" and see where we are. Primary pressure, 300 volts. In the secondary of the 80 light converter we use 100 volt lamps at .75 ampère each. I use here 100 volt lamps to compensate for the heavier expense of primary wire. Current in primary 20 ampères; current in secondary, 60 ampères. Now should a ground occur, the difference in pressure is small and it may easily happen that a fuse will stand twice or three times the current it is designed for, and then, without knowing it, we would have the dangerous primary current in the secondary circuit. We at once see that a fuse in the primary in this system is no protection, but just the opposite that Mr. Brown wished it to be. He will have no difficulty in demonstrating that 200 to 300 volts alternating current can be fatal, and, therefore, as fuses are no protection, the adoption of his propositions will be eminently dangerous.

At the end of his paper Mr. Brown imagines that he has now proved everything, and wishes the Board to adopt his rules without delay. If everybody's ideas and rules were to be adopted and followed we should not be able to find any electric light stations. I hope the Board of Electrical Control will not rush this time into rule-making before thoroughly investigating the matter.

WHEN ARE ALTERNATING CURRENTS FATAL?

1. From about 200 volts and more, if a man is connected in series with the line and dynamo, and so fixed to it that he cannot leave the wires. (Experiment of Harold P. Brown.)

2. From about 300 volts and more when a person, touching two bare wires, places himself in series with the dynamo and stands on damp ground, making connection to earth when the dynamo supplies no, or very few, lamps.

3. From about 800 volts and more if a person touches both main wires, a few lamps only are being supplied, and he cannot disconnect himself from the conductors.

4. From about 800 volts and more when touching the bare circuit wire with one hand only, and the body connected by metal (an iron pole) or damp ground to earth.

The above are a few of the conditions which can, or generally will, prove fatal; the physical condition of the body is of course a very important factor.

ALTERNATING CURRENTS ARE NOT FATAL:

1. With a pressure up to 3,000 volts, if a person does not stand on damp ground, no permanent connection is established and the dynamo supplies a large number of lights. (Case cited.)

2. With a pressure up to about 1,500 volts standing on damp ground, if the dynamo has a great number of lights to supply and the connection is not permanent.

3. With a pressure of about 1,200 volts, if a person standing on dry ground touches with both hands two bare ends of the wire which connect the primary of a converter to the main line, placing himself thereby in series between dyna no and converter, the dynamo supplying a number of lights.

It is well known that the strain increases with the pressure, and also that the effect of an alternating current on the surrounding insulation is far greater than that of a direct current of the same pressure. This can be explained if the action of an alternating current passing through a body is understood.

Assume a man substituted as a part of the circuit, the consequence will be that a minute current will flow through the line, owing to the great resistance of the horny substance forming the skin. The internal part of the body has but very little resistance; therefore the current will penetrate the high resistance from one end of the wire to the low resistance of the interior of the body, and from there through the skin to the other end of the line. In penetrating, the current appears in the form of a spark which singes the skin, whereby the latter is reduced in thickness. This is the cause of decrease in resistance. Each reversal reduces in this manner with greater success than the previous one the opposing resistance, since each impulse carries a proportionally stronger current as he resistance diminishes. If the skin is so removed, a comparatively large current can flow and influence the actions of the heart and other organs.

The first condition experienced by a not too powerful shock is the contraction of the internal organs similar to that observed when a person tries suddenly to lift a heavy weight. At the same time the capacity of the senses is reduced.

The conclusion I come to is that the conditions of the circuits have a great effect upon the result. With a great many lamps, say, all the dynamo can supply in circuit, the resistance of the line will be low, and if now a man touches both the brushes (forming a shunt to the main circuit), his resistance being high as compared to that of the line, he will receive a shock; but the current is small, and the result will not be fatal if he does not make ground connection or grasp the two brushes with both hands. With only a few lamps in circuit the difference in resistance between the body and the line is decreased, and the same person under the same conditions, but varying loads, and by the same dynamo, may in one case be merely frightened, while in another he may be hurt or even killed. This would indicate (provided I am correct) that during daytime there is more danger from such currents than during the evening, when dynamos are working up to their full capacity.

The reader having followed so far, will immediately see my objection to the experiment of Mr. Brown, who employed one unsuitable converter, constructed for totally different work, in series with a dynamo doing no other work than supplying this converter.

To prove what Mr. Brown wished to do, I advise him to try to defeat the alternating people by their own work. To prevent other people having any objections (like me) to converters or conditions of experiment, he should ask a firm for permission to operate at any station where dynamos are at work with one or more converters belonging to that firm. I have no doubt that his request will be willingly granted, in view of the great importance of the question, which has become of general interest. Only such results will prove whether alternating distribution is safe or not.

With regard to fuses, I wish him to effect on a converter, as manufactured, an artifical connection between primary and secondary, and see how long the fuse will last, and how many times he would have to multiply the size of the fuse before it will be strong enough to stand the current. Precaution must be taken with large fuses, as an armature can easily be destroyed. Also, let him place a dog between dynamo and converter, interpose a two-way switch which will connect the dog in series with the dynamo and converter the moment when connection between converter and dynamo is broken, as follows:

1. Connection to dog by means of bare wires attached to legs and damp cotton. Dog not to be chained down, but allowed to free himself if he can. Pressure, 1,000 volts. Secondary circuit open.

2. The same experiment with better connections. Cotton wet.

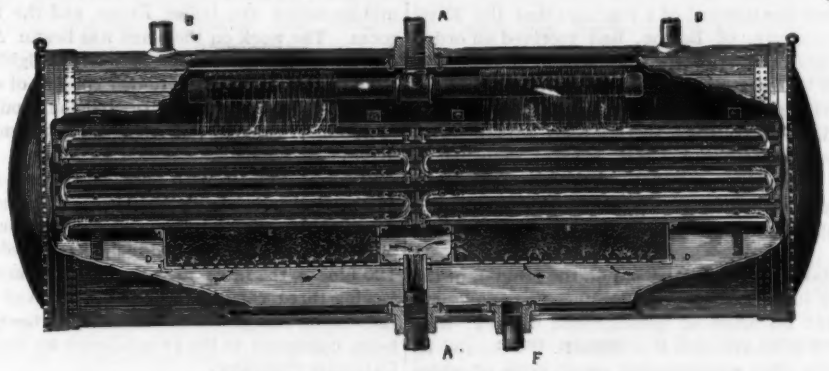
3. The same experiment as in case 2, and the secondary circuit closed. This case may prove fatal.

I should be very much pleased to read the results of experiments under above conditions in the columns of this journal.

In concluding, I wish to say that in spite of the great difference of opinion between Mr. Brown and myself, we agree upon one point, viz., *that public safety is the first question.*

The Stilwell Live Steam Feed-Water Purifier.

Where water used in boilers contains only carbonates of lime and magnesia, these deleterious elements are usually removed in heaters using exhaust steam. But in many cases such water also contains sulphates of lime and other impurities which require a greater degree of heat to precipitate them than can be obtained with exhaust steam; and the exhaust heater is ineffective. This has been recognized by the Stilwell & Bierce Manufacturing Company, of Dayton, O., who have recently brought out the Stilwell "live steam feed-water purifier," which is shown in the accompanying engraving. It consists of a horizontal cylinder, made of best steel boiler plate, and may be placed in any convenient locality above the boilers to be supplied, and with which it is directly connected.



A NEW FEED-WATER PURIFIER.

The cold water, or water from the exhaust heater, is introduced at *A* through a pipe connected by a tee with a horizontal pipe inside the shell. Both ends of this horizontal pipe are perforated with many small openings, through which the water escapes in the form of a shower. Live steam is admitted at *B B*, filling the purifier with steam at boiler pressure. The water falls from the induction pipe through a body of steam into the top of two series of shallow iron pans, each pan being one-half the length of the purifier shell. These pans are provided with openings in the bottom at alternate ends, and the water is compelled to traverse their entire area in a thin sheet.

As the heat and pressure in the purifier is the same as in the boilers, the water, in its passage over these pans, is subjected to the same chemical change as in ordinary boilers, and is relieved of all scale-producing impurities, which are precipitated upon the surface of these pans, from which they can be quickly and easily removed. After passing the circuit of the pans, the water drops into the large settling chamber *D D*, in the bottom of the purifier, where the non-crystallized impurities deposit in the form of slush or mud, and are blown off at frequent intervals through the blow-off *F*. To complete the work of purification, the water passes through the filtering chambers *E E*, which are filled with coke or other suitable material, into the pure water chamber, then into the boiler through pipe *A*. It is claimed that the feed-water is then absolutely pure, and at substantially the same temperature as the water in the boiler, thus effectually preventing the deposit of sediment in the boilers, and the strain upon the boiler incident to the introduction of water at a low temperature. Each end of the purifier is provided with a heavy head fastened in place with cap screws. The depositing pans slide on ways which are fastened to the shell, and can easily be removed through either end of the shell for cleaning, and any impurities which may attach to the bottom of the purifier shell can readily be raked out, as the removal of the head exposes the entire inner structure.

As many electric light stations are situated in localities where water is highly impregnated, such an apparatus as that just described will be of undoubted benefit.

Special Correspondence.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTICAL WORLD,
178 Devonshire Street, Boston, Aug. 31, 1888.

Thomson-Houston System.

The Thomson-Houston Electric Company report the following new plants: Braidon, Vt., 30 arcs, 200 incandescents; National Express, Kansas City, Mo., 200 arcs, and the following increases: Salem, Mass., 35 arcs; Bridgeport, Conn., 1,600 incandescents; Fall River, Mass., 50 arcs; Paterson, N. J., 600 incandescents; Brockton, Mass, 50 arcs; Fort Plain, N. Y., 30 arcs.

Boston's Electrical Supply House.

It was enterprise, backed by pluck, which prompted Messrs. F. E. Pettingell & Co. to establish a completety stocked electrical supply house at the intersection of Congress and Franklin streets, Boston, a few months ago. It was a venture, but a liberal patronage has already turned this venture into an assured success. Many New England dealers in electrical goods, and superintendents of electric light stations and plants, have become patrons of Messrs. Pettingell & Co.'s establishment. This firm are the N. E. agents for the Okonite Company, of New York; Phœnix Glass Company, of Pittsburgh, Pa.; Cleveland Motor Company, of New York; Forest City Electric Works, of Cleveland, O., and the Parker-Russell Mining and Manufacturing Company (manufacturers of "Sunlight" carbons), of St. Louis, Mo. The firm reports business very good, considering the season of the year, and the prospects for a large fall trade very encouraging. Among the recent sales made was one which merits special mention. This was an order for sufficient Okonite wire for connecting up one thousand incandescent lights in the Equitable Life Assurance Society's Building in Boston.

Purchase of a Carbon Plant.

The Thomson-Houston Carbon Company has purchased the business and good will of the Richmond Carbon Company, North Adams, Mass. Mr. C. T. Richmond, of the last named company, will hereafter be connected with the Thomson-Houston Carbon Company as manager, and will make his headquarters at the company's factory at Fostoria, Ohio.

Clark Cable and Wire in Japan.

It came to my knowledge upward of a year ago that the Eastern Electric Cable Company, of Boston, had received an order for several miles of cable and wire for shipment to Japan. No mention was made of this matter at that time in THE ELECTICAL WORLD, thus complying for good reasons with the wishes of all the parties interested. The contract having been satisfactorily filled and passed upon, Mr. Henry A. Clark, general manager of the Eastern Electric Cable Company, has given me for publication some interesting facts and figures regarding his company's shipments of cable and wire over a year ago to the Edison plant at Tokio, Japan.

This plant was installed in the palace and on the grounds of the Mikado, and has been in successful operation since its completion. There are in the plant 26 miles of underground "Clark" wire and cables, of which 8 miles are sizes 0 to 0000 B. W. G., and 73 miles of inside wires—a total measurement of 99 miles of cables and independent wires, with a total weight of 51 tons. The underground wires and cables were laid in conduits from the dynamo to the palace, the distance between the former and the latter being about three fifths of a mile. The final shipment on the cable and wire contract was made July 31, 1887. A percentage of the purchase money, amounting to several thousand dollars, was left on deposit with a trust company on August 5, 1887, as a guarantee of the insulation of the Clark underground wires and cables, and this sum was released by cable from Japan on Aug. 4, 1888, and paid over to the Eastern Electric Cable Company.

Manufacturing Facilities Increased.

The factory of the Eastern Electric Cable Company, Nos. 63 to 67 Hampshire street, Boston, has again been enlarged, and an immense amount of new machinery, improved braiding machines, etc., etc., are being added to the equipment of the original factory and the fitting up of the new building. This is the third enlargement of the factory within two years. By the first of September (when new machinery is all moved in), the company's capacity for manufacturing the "Clark" wire will be double what it has been up to the present. Mr. H. A. Clark, the manager, and Mr. H. H. Eustis, the electrician of the company, supervise the manufacture and inspect every foot of the cable and wire made at the factory.

The Boston & Sandwich Glass Company.

A special dispatch from Sandwich of Aug. 21 says: A self-constituted committee, comprising some of the leading and most influential business men of the town, visited the directors of the Boston & Sandwich Glass Company yesterday with a view of ascertaining something further as regards the closing of the factory at Sandwich. The directors expressed themselves as being willing to resume work if the citizens or any other parties would purchase of the estate of the late president, John W. Parker, some 500 shares of the stock, valued at about $12,000. It is thought that unless this was done the company would keep to their action of last week, when it was voted to dispose of the stock and factory.

W. L. B.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
44 Lakeside Building, Chicago, Aug. 31, 1888.

The Sprague Electric Railway and Motor Company.

Mr. C. W. Barclay, the Western manager of the Sprague Electric Railway and Motor Company, informs me that the prospects for a brisk motor business in this city are flattering. The Edison central station plant has just started up with its power circuits, and this will enable him to put in motors. At Davenport, Ia., he informs me that the street railway power plant is just starting up with the first installation of a Sprague motor, with several others to follow. The stationary power plant will start up in about three weeks. The company have already arranged with parties for the installation of several motors of 10, 15 and 20 horse-power each. A. D. Lundy, the electrical engineer of the Western office, is now devoting his entire attention to the completion of the Lafayette electric railway, which is expected to be in operation next month. Mr. Barclay has secured stores in the basement of the Rookery building, in which building are also located his offices, where he will carry a complete stock of motors and the different parts. He will thus be able to supply customers direct, without the loss of time incident to ordering from the factory. Shipments from the factory were made him during last week.

Long Distance Telephoning.

A special from Minneapolis, Minn., dated Aug. 20, states that the experiment of telephoning over telegraph wires between St. Paul and Duluth was successfully made that morning under the direction of Superintendent of Construction P. G. Reynolds, Manager W. B. Joyce, of the St. Paul Telephone Company, and General Superintendent Warman, of Minneapolis. A long distance telephone was placed in the central office on Third street and another at the central office at Duluth. From the Telephone offices the wires run to the offices of the North American Telegraph Company at both ends, and there were connected with the telegraph wires. A conversation over 180 miles of wire was held with as much facility as though merely talking over city wires. Manager Joyce explained the difference between the long and short distance telephones, the former being so delicately constructed that, if used for short distances, the wafting of a piece of paper in front of the instrument could be heard by a person at the other end of the line. He further stated that at an early date a long distance telephone company would commence the construction of lines between St. Paul, Chicago, Milwaukee, Minneapolis and Duluth.

The Chicago Edison Plant.

This enterprise was started for the purpose of furnishing light and power on the Edison three-wire system on a larger scale than had been before attempted, the actual capacity of the station being 50,000 lights at one time or their equivalent in power.

The building is 45 feet by 190 feet long, divided by cross walls into three parts The offices are arranged in the front portion facing Adams street, which rises to a height of three stories. The middle portion, 103 feet long by 45 feet wide, is two stories high, the engines occupying the ground floor and the dynamos the upper floor. The rear portion is made up of three stories and basement. The basement is reserved for handling ashes; the two middle stories are boiler rooms, and the third floor is the coal room. The work on the plant was begun Aug. 1, 1887, and the machines were started for commercial lighting Aug. 6, 1888.

The plant as installed to-day consists of eight Edison dynamos each of 1,250 lights capacity, and four double disc engines, each of 230 h. p. capacity, of Armington & Sims make. Each engine drives two dynamos.

Steam is supplied with four boilers, each of 300 h. p. capacity, of the Heine Safety Boiler Company's make. A system of underground conductors from the Edison Machine Works is laid for 50,000 lights capacity, made up of 23 feeders and mains facing 120 blocks, the faces making in all 16 miles of tubes, each tube having three conductors. This system of tubing terminates at the station end just inside the walls of the station, the conductors being continued to the switch-board by single cables made by the Callender Company.

The task of designing and installing the electrical work was placed in the hands of Mr. W. S. Andrews, and the mechanical engineering in those of Mr. F. Sargent. The large experience and engineering ability of these gentlemen, together with the means placed at their disposal, has secured for the Chicago Edison Company a plant thoroughly complete in all its appointments, with many new improvements and appliances designed especially for this large class of work.

The electrical apparatus for regulating and distributing the current is arranged on two sides of the dynamo room. On one side are the dynamo regulators, and switches for throwing the dynamos on and off the circuit; also two large ammeters, each calibrated for 1,500 ampéres, and 8 dynamo ampèremeters for 650 ampères each, with standard pressure indicators, and special arrangement for throwing dynamos in circuit without disturbing the light. On the other side of the dynamo room, occupying nearly the entire side of 103 feet, are the equalizers, standard and comparative pressure indicators, feeder switches, safety catches and ammeters. Each feeder is furnished with two of the latter instruments, one on the positive side and one on the negative. This, I believe, is a new feature, and has been introduced in order to facilitate a correct estimate of the distribution of load, and to afford a ready means of locating trouble. The extra large switches in this station, the use of which was necessitated by the very heavy currents carried, were made by J. Lang & Co., of this city, being specially designed by Mr. W. S. Andrews for the purpose.

The dynamos installed are of the largest size now in use, the net weight of each being about eight tons. They were made by the Edison Machine Works, of Schenectedy, N. Y., and are of the same type as those illustrated in your August 15 issue, in the special Supplement.

The current is sold the public by meter, so that each consumer is charged for the exact amount of light that he uses, and is thereby enabled to economize at will in the same way as he would do with gas. These meters have been in use for many years in New York and many other large cities, and have been proved to be very reliable; in fact, the percentage of error never exceeds 2 per cent., which is a far better result than has been attained by the gas meter. Furthermore, the *quantity of light* is measured, and not a *material* to be burnt, which, as the public have often found out to their cost, may consist partly of air and partly of illuminant in varying proportions.

E. L. P.

KANSAS CITY, Mo., Aug. 20, 1888.

The Inter-state Plant.

An Ideal engine and a Fort Wayne Jenney dynamo have arrived for the central station plant of the Inter-State Electrical Company.

Electric Railways.

It is now a settled fact that the West Side Electric Railway, of Kansas City, Kan., will be put under construction as soon as the necessary official publication of the granting of the franchise has been accomplished. The arrangements are made, and everything is in readiness to push the work to completion at an early date. The contract has been granted to the Thomson-Houston Company, and cars similar to those on the West End Line in Boston will be put on.

Reed Springs, Mo.

The Kansas City agency of the Hawkeye Electric Light Company, of Oskaloosa, Ia., has secured the contract for a 125 incandescent light plant to be put in the Reed Springs Hotel at Reed Springs, Mo. A 200-light dynamo will be put in.

Arkansas City, Kan.

The Arkansas City, Kan., Electric Light Company has let the contract to the Kansas City, Mo., agency of the Thomson-Houston Company for a considerable addition to the arc and incandescent light plant of the company.

The Train Telegraph System.

Superintendent Kortz, of the Union Pacific telegraph of Omaha, Neb., and Superintendent Dickey, of the Western Union, of Omaha, have just returned from an investigation of the railway induction telegraph system as in operation on two divisions of the Lehigh Valley Railroad. They were greatly pleased with it, and the system is soon to be tested on a division of the Union Pacific. They report that President Adams, of the Union Pacific, is anxious to introduce the system on that road, but is somewhat deterred by the great cost of such an undertaking. It is probable, however, that the fast trains, officers' cars and the most important stations will be equipped in any event.

Poisonous Lightning.

A Mr. Sullivan, living north of Nevada, Mo., a town near here, lost a cow last week by lightning. He removed the animal's hide and allowed the hogs to feed on the carcass. Since then all the hogs have died, their mouths swelling so they could neither eat nor drink. Mr. Sullivan's arms are also swelling alarmingly, and it is the opinion of the doctors that they will have to be amputated. Mr. Sullivan states that the cow was a perfectly healthy one, and that he has no reason to suspect she was poisoned, and he thoroughly believes that the lightning made the animal's flesh poisonous.

Conduit Ordinances.

The present city council is a new one personally, an election having been held lately. During the term of the old council and about six months ago two ordinances were introduced granting franchises for conduit systems, but as yet nothing has been done with them further than reference to committees, and the new members seem not to know what a conduit is, let alone that conduit ordinances are pending.

A Pan-Electric Suit.

Papers have been served upon the Johnson County, Mo., Telephone Company in pursuance of the filing of a complaint against that company in the United States Circuit Court in this city by the American Bell Telephone Company, asking for an injunction and for damages. The Johnson County Company has been operating the Pan-Electric telephone system in Warrensburg and Holden. Before the company went into operation they offered to let the Bell Company have the field on the condition that the rates be only from a fourth to a half as much as those usually charged by the Bell Company. This the Bell Company refused, saying that such rates would bankrupt it. Then the Johnson County Company went ahead at the low rates, and so, according to the Bell Company, has been a losing concern from the start, and when the Bell Company asks for damages the court will be asked to point out how it could be damaged by a losing concern. But the fact is the Johnson Company made quite a good profit with its low rates.

The Kansas City Exposition.

The local agency of the Thomson-Houston Company has secured the contract for putting a $20,000 electric light plant in the Kansas City Exposition building. The company is under a heavy obligation to have the entire plant in full operation by the night of Aug. 29.

St. Joseph, Mo.

A recent electric storm in St. Joseph, Mo., caused the burning out of over 300 telephones.

Where the Lightning Strikes.

Last Saturday, Mescott, chief of the Kickapoo Indians, and his squaw and five children were killed by lightning in his cabin on the reservation, near Netawaka, forty-five miles west of Atchison. A sixth child escaped from the shock. A farmer named Cresbaw, living five miles southwest of Newton, Kan., had two horses and a mule killed by lightning last week. The week before he lost $80 worth of hogs the same way.

Pine Bluff, Ark.

The Western Electric Construction Company is busy preparing to carry out its contract for equipping the Pine Bluff, Ark., Water and Light Company's electric light plant. The plant will include 2,500 incandescent lights and 70 arc lights. The Western will do all the outside wiring, erect the pole line, and fully equip the station.

New Brush Plants.

W. O. Steele, representing the Brush Electric Light Company, has secured the contracts for putting in 50 incandescent lights at the water-works station at Quindaro; 100 lights for the Abernethy Furniture Company, and 60 arc lights for the Little Rock, Ark., Electric Light Company.

K. C. M.

BUSINESS NOTICES.

Jordan & Gottfried, 208 Canal Street, N. Y., carry a complete stock of iron and brass machine and wood screws, bolt, cap and set screws, taps, dies, files, twist drills, brass and rubber tubing, rod and sheet copper, brass, German silver, steel and iron wire, shafting, tools, etc.

The Partz Electric Battery Company, of Philadelphia, having found their old quarters at 1,723 Chestnut street too small, have leased the large building at 636 Arch street, same city. They are now prepared to fill all orders promptly, and in addition to their large line of Open Circuit and Gravity and Motor Batteries, have a full line of small Motors and Dynamos. Send for their price list and catalogue, or write to them stating what you want.

Owing to the pressure on our columns this week, the Departments and the Patent Record are omitted.